THE

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THE

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COMMERCIAL ASPECT OF ELECTRIC TRACTION IN GREAT BRITAIN.

ONE of the most important questions of the day is that of electric traction. Hampered by ill-advised pseudo socialistic legislation, Great Britain to-day, which ought to be in the van of the world in respect of electric traction, and whose requirements are comparatively greater than those of any other country, is far in the rear. Writing on this subject in the *Engineering Magazine*, Mr. Emile Garcke gives a very clear exposition of the present state of this question. He shows how the traction industry has been choked by the same class of legislation which retarded the early electric light industry, and has proved so ruinous to the tramways of Great Britain. Those who have not studied the question of electric traction and of tramways generally can have little conception of the facts. The ordinary public is apt to think that if tramways have been so far a failure, there can be no hope for other forms of traction which propose to supersede horse traction. But the idea is quite erroneous. Tramways have been stifled by the law. Their proprietors have felt the hopelessness of the situation and have given up trying. Electricity offers the opportunity for an elastic service. It is clean, rapid, and frequent, in the service it gives, and the plant can be worked up to full capacity. As Mr. Garcke points out, about four-fifths of the motive power of a horse tramway is in the stable resting or feeding, and car service cannot be increased without a great increase in the number of horses. This is not so with electricity, by which an ever-increasing service can be carried on at a relatively less cost of working.

The supply creates the demand. Steam trams seem to run at half-hour intervals. Of what possible use can they be except to pick up the accidental passenger. With a 10-minutes' service traffic is compelled, and without increase of population, electric traction causes more people to be carried. Electric traction, in fact, is intended for people who now either walk or do not move. Given facilities, they learn to ride, and the electric cars are thus popular. They improve a district, and properties along their route appreciate in value, and extension is soon called for in place of being resisted, as it has hitherto been. In America there are now hardly any horse-worked tramways, but there are over 20,000 miles of lines electrically run. In Massachusetts alone, with a population less than that of Yorkshire, the tramway mileage exceeds that of the United Kingdom.

In England alone has electric traction languished, and it is to be regretted that this is now entirely due to the foolish attitude of municipal and corporate bodies. To such an extent has this folly been carried, that Leeds and Bradford, two large contiguous cities, have each set up their own local lines, and have put them down to different gauges, and this one injudicious act leaves these two towns still at the mercy of the steam railroads.

D

Municipal authorities have entirely missed the true interests of their ratepayers. They can do no real good by their little local lines, and they cannot fairly apply their rates to tramway extensions beyond borough limits. Hence stagnation and loss. Mr. Garcke is in favour of local authorities owning the lines within their areas and receiving a suitable rental, but he would not have such lines worked except by private enterprise. It is a pity that of late there has been a tendency to look on private enterprise as usurpation. It is to private enterprise we owe our commercial supremacy, and it is owing to a departure from these lines that we find ourselves being ousted by the foreigner. But the mischief has been now perceived, and the near future will probably see a check to the carrying on of huge enterprises by the Little Peddlington authorities, who are unfitted to enter upon such works. Obviously until the Light Railways Act admitted of greater freedom from confiscation tramway enterprise could not prosper. Electric tramways require large capital, costly machinery, and huge power houses, and capitalists would never find money for such undertakings until they were secured in their property. The success of the British Electric Traction Company, of which Mr. Garcke is the able director, is a signal proof that capital is ready to be put into tramway undertakings as soon as it feels safe. As showing the obstructive efforts of certain municipal authorities, Mr. Garcke cites three cases of towns whose officials have barred progress by imposing impossible conditions. So onerous were their demands that the towns in question have now no electric traction, and the ratepayers, did they but know it, have been deprived of a necessity by the greed and obstruction of their own representatives. Mr. Garcke very properly asks that so long as an electric tramway company performs its part of the bargain it may make with a municipality as to profit-sharing or rental of lines the lease should be permanent and indeterminable.

It is under these conditions alone that the public can expect the best possible service and latest improvements, and that the company can be afforded reasonable security of future reward for present sacrifices.

Municipal authorities would do well to ponder over this article and reflect, before it is too late, whether it were better to give rein to the self-aggrandisement of one or two local busybodies or to allow outside enterprise to step in for the benefit of the whole people; for we have ourselves observed that it is often to the mischievous conceit of an odd man who rules a council that much mischief arises. When such men are both strong and intelligent, their influence is invariably good; but often we find such men are simply strong and deplorably ignorant, and if it were not pitiable, it would be amusing to tell how a few men in the ugliest possible of towns endeavour to demand costly conditions as the price of their consent. There are not a dozen towns in England which will not be improved by the overhead electric system, and in the very worst towns of all we find men who make believe that their local beauty will be destroyed. Electric traction must come, and it will, but first to the more enlightened towns, and leave the outsiders to lag still further behind in the race.

THE PROGRESS OF ALTERNATING CURRENTS.

In an interesting article which appeared in the *Electrical World* for March 4th, 1899, Messrs. Houston and Kennelly review the progress made in the commercial application of alternating currents during the past 25 years. When we remember that 25 years ago electrical engineering generally was but a new-born child and recognise that it has now attained to vigorous manhood, we expect to find a record of advancement by leaps and bounds.

Alternators were applied commercially in the very infancy of electric lighting, but were for some time to a great extent superseded by continuous current dynamos, one reason for this being that alternators of large output required continuous current exciters, and another being—as the writers of the above-mentioned article very properly add—the very meagre knowledge of alternating currents, either theoretically or in their practical application, which then existed.

If it were not for the frequent desirability of transmitting power electrically over considerable distances the progress made by alternating currents would have been greatly retarded, but the frequent existence of large quantities of water-power at distances from large towns rendered the transmission of power therefrom very desirable if not imperative. The existence of a power station in the midst of a thickly populated district demands an exorbitant capital outlay, so that economical interests often necessitate the erection of a central station at some distance from the centre of distribution. The cost of transmission mains then necessitates the adoption of high voltage, which again calls for the use of alternating currents. All these considerations have, of late years, impelled the best electrical engineers to turn their attention to problems upon whose solution the successful transmission and distribution of energy by alternating currents depend.

Little difficulty was encountered in the adoption of alternating currents for lighting purposes only, but when motive power was required alternating currents seemed altogether unsuited for the purpose. An ordinary alternator could be run as a motor, but only after being mechanically run up to synchronism with the supply currents. Such motors answer their purpose satisfactorily where they are required to run continuously day and night, but are practically useless for intermittent work, in which they may be required to be stopped and started many times a day.

The urgent need of a self-starting motor for use on alternating current circuits resulted in the invention of polyphase rotary field motors and subsequent development of self-starting monophase motors. These motors have now been improved to such an extent that, when running on load, their performances are equal to those of direct current motors of similar outputs. Induction motors—as these are frequently called—have, however, two serious defects which must be overcome before alternating currents can have as universal an adoption as continuous currents.

Although induction motors are self-starting, their starting torque is too small to start on full load; and, again, their power factor on load rarely exceeds 80 or 85 per cent. The former defect requires that the motor shall start on a loose pulley, and so run up to speed before load is put on; the latter is objectionable since it increases the losses in the mains per unit of power transmitted, renders the regulation of the plant extremely difficult, and necessitates a plant of greater current capacity than would be required by an equal non-inductive load. The magnitude of these serious defects cannot be gainsaid; they undoubtedly greatly prejudice the adoption of alternating current plants, and we may expect that their removal will be followed by a rapidly increasing adoption of alternating currents in the erection of new electric plants.

The progress of alternating currents in their commercial application has been during the past 25 years very great indeed, but it is to be hoped that the next few years will witness those finishing touches which are necessary to make alternating currents as easy of adoption in distribution for all requirements as are continuous currents.

ON OSCILLATORY AND ROTATORY MAGNETIC FIELDS, AND THE THEORY OF THE SINGLE-PHASE MOTOR.

By MICHAEL B. FIELD.

(*Concluded from page* 493.)

Figs. 10 and 11 are curves obtained diagrammatically as explained for a certain 20 H.P. two-phase motor when working (*a*) as two-phaser ; (*b*) as single-phaser.

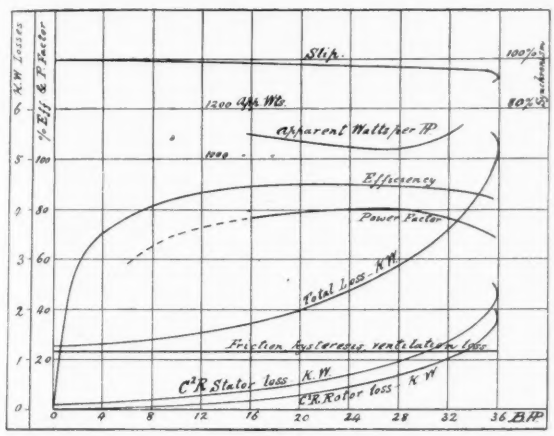


Fig. 10.

The data of the motor in question are as follows :—

B.H.P. rating	= 20
Volts	= 500
Poles	= 6
Frequency	= 40
Speed per minute	= 800
Rotor diameter	= 350 m.m.
„ length	= 200 mm.
Number of holes in stator	= 60
„ „ „ rotor	= 45

Stator winding equivalent to three coils of 78 turns each per phase —two phases.

Rotor winding equivalent to three coils of 10 turns each per phase —three phases connected Y.

No load or magnetising current per phase as two-phaser = 9 amperes.

Leakage coefficient of stator (measured) = 5 per cent.

Resistance of stator per phase = 0·5 ohms.

Resistance of rotor per leg = 0·0112 ohms.

Fixed losses or those due to friction, ventilation, hysterises, &c. = 1·150 kw.

From figs. 10 and 11 we gather that the above motor breaks down at 36 B.H.P. as two-phaser, and 15 B.H.P. as

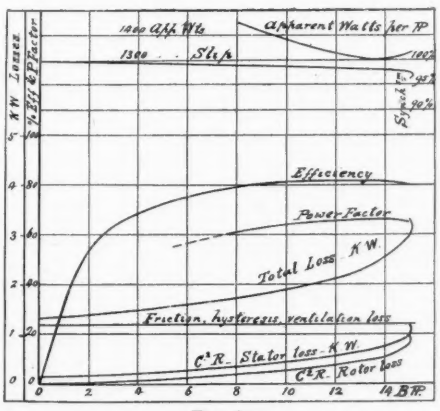


Fig. 11.

single-phaser (only one stator phase winding being supplied with power, and that at the normal voltage). The maximum efficiency as two-phaser is 89 per cent., as single-phaser 81 per cent. The maximum power factor as two-phaser is 80 per cent., as single-phaser 66 per cent. The minimum apparent watts per H.P. as two-phaser is 1,040, as single-phaser 1,400. The breaking down point occurs at a slip of 6 per cent. as two-phaser, and at 3 per cent. as single-phaser.

Before concluding this paper it will be advisable to take one point on the curves for the above motor when running first as two-phaser and then as single-phaser, working the complete diagram out for each case.

We will take it that by comparison with other similar rotors we know that the breaking down point, if in a constant field, will occur at 10 per cent. slip or at a speed of 720 revolutions per minute.*

Let F be the rotating field necessary to produce 500 volts back E.M.F. per phase of the stator winding.

The E.M.F. per rotor phase at 720 revolutions will clearly be

$$500 \times \frac{10}{78} \times \cdot 1 = 6{\cdot}4 \text{ volts.}$$

The apparent resistance per rotor phase at this speed will be $\sqrt{2} \times 0{\cdot}0112 = 0{\cdot}01585$ ohms, and the current per phase = 404 amperes. The rotor wave will thus be equivalent to

$$404 \times 10 \times 1{\cdot}5 \text{ ampere-turns,}$$

and the corresponding stator wave will be given by a current per phase of

$$\frac{404 \times 10 \times 1{\cdot}5}{78} = 77{\cdot}7 \text{ amperes.}$$

We have then the relation that $C_s = \cdot 192\ C_r$, where C_r = rotor current per phase, and C_s = the stator current per phase needed to balance the effect of C_r.

Let us now complete the diagram for the two-phase motor at a slip of 6 per cent.

Referring once again to fig. 9, let us make the distance, $o\,n_1$ equal to 10 cm. Then the speed scale will be 1 cm. = 1 per cent. synchronism. From the centre, o, we describe a circle such that the horizontal projection, $b\,f$, for a slip of 10 per cent. equals 77·7 mm. These projections will then read direct in amperes in the stator per phase.

Joining the point representing the slip of 6 per cent. with the centre, we find the horizontal projection to be 56·9 mm. representing a rotor current per phase of $56{\cdot}9 \times 5{\cdot}2 = 295$ amperes, or a balancing stator current of 56·9 amperes per phase. To this we add the magnetising current of 9 amperes per phase and obtain as total stator current 62 amperes.

Now, with the rotor on open circuit 5 per cent. of the lines generated by the stator do not thread through the rotor bars, hence the leakage E.M.F. is $\frac{25}{9}$ or 2·78 volts per ampere per phase. The E.M.F. due to leakage with 62 amperes per phase will thus be 172 volts.

Let us choose a volt scale of 1 mm. = 5 volts so that the length, $o\,n_1$, may be taken as representing the back E.M.F. due to the field F.

We set off $o\,p = 172$ volts, $p\,q = 62 \times \cdot 5 = 31$ volts, $q\,r = 500$ volts, and obtain as the necessary supply E.M.F. $o_r = 641$ volts.

If we now reduce all currents and E.M.Fs. in the proportion of 641 : 500 we get—

* We can readily calculate what percentage leakage this corresponds to since we have

$$4\,L = \cdot 0112,$$

where L represents the voltage per phase in the rotor due to the leakage lines produced by one ampere per phase and a frequency of one cycle per second. With 9 amperes, 78 turns per coil, 40 cycles, we get a back E.M.F. of 500 volts; hence with 10 turns, 1 ampere, and 1 cycle per second,

$$\text{E.M.F.} = \frac{500}{40} \times \frac{100}{78^2} \times \frac{1}{9}$$

and hence remembering that the rotor is wound with three phases, the effect of which is 1·5 times that of one phase, we have

$$L = \frac{500}{40} \times \frac{100}{78^2} \times \frac{1}{9} \times 1{\cdot}5 \times \frac{x}{100} = 3{\cdot}41\,x \,.\, 10^{-4},$$

where x is the percentage rotor leakage.

Hence from the relation $4\,L = \cdot 0112$ we see the leakage = 8·2 per cent.

Supply E.M.F. ...	= 500 volts.
Stator current per phase	= 48·3 amperes.
Power factor (= cos ϕ)	= 0·66
Input	= 48·3 × 500 × 66 × 2 = 31·9 kw.
Stator C^2 R loss ...	= 2·33 kw.
Rotor current per phase	= 230 amperes.
Rotor loss	= 1·78 kw.
Fixed losses ...	= 1·15 kw.
Total loss	= 5·26 kw.
Efficiency	= 83·5 per cent.
Output	= 35·6 B.H.P.

Input calculated from slip and rotor and stator losses is as follows :

Rotor loss at 6 per cent. slip = 1·78 kw. Hence total power imparted to rotor by revolving field = $1{\cdot}78 \times \frac{100}{6}$ = 29·65 kw. Adding to this the stator loss of 2·33 kw., we get the input 31·98 kw. as against 31·9 kw. obtained from diagram by scaling off stator current and power factor.

Of the 29·65 kw. imparted to the rotor, 1·78 or 6 per cent. is lost in heat, and 27·87 kw. are developed. Deducting the fixed losses for friction, &c., of 1,150 kw., we get as useful output 26·72 kw. = 35·7 B.H.P. It is not, of course, quite correct to deduct the total hysteresis loss from the power imparted to the rotor as the loss due to that cause really occurs in the stator. To be strictly accurate we should separate the hysteresis from the other fixed losses (friction, ventilation, &c.) and allow for them separately. The error, however, introduced by the above treatment is of no importance when we are employing a method which is only approximate.

In the foregoing curves the hysteresis torque on the rotor (this being in the direction of rotation) has not been allowed for. The correction is easily made when the hysteresis loss is known. In the case of an ordinary rotor the hysteresis torque is but small, being usually barely sufficient to keep the rotor running at full speed on no load with the slip ring brushes raised.

We will now repeat the diagram for the same motor for a slip of 3 per cent. of synchronous speed, when only one phase is supplied with current.

Choosing the same scales as before, and assuming the existence of two rotating fields, F, whose polar diameters coincide for the time being with the axis, o n_1, each field being of the same magnitude, as in the previous case we obtain, as already explained, the following :— Horizontal projection (fig. 12) $b f$ = 31·7 mm., representing a forward travelling stator wave of 31·7 amperes, or rotor wave of 165 amperes ; horizontal projection, $c g$ = 99·5 mm., representing a backward travelling stator wave of 99·5 amperes, or rotor wave of 518 amperes. Adding in each case the stator magnetising wave of 9 amperes, we obtain as forward stator wave, 35·5 amperes ; backward stator wave, 108·5 amperes.

We now reduce the backward field in the proportion of 108·5 : 35·5. This we may do graphically by means of parallels, since o n_1 represents the old value of F, o v will represent a new value such that the corresponding stator wave has a magnitude of 35·5 amperes.

The forward and backward waves we may now combine into an oscillating one. Imagine the vectors of the diagram to have moved forward by the angle ψ, then the two current waves will coincide representing the maximum of the oscillating, the forward field will have moved to the position, o u, and the backward field to the position, o w. Now this backward field precedes the current by the angle, χ, and the E M.F. it produces in the stator winding will be the same as if we reverse its direction (*i.e.*, take it to be directed outwards), at the same time assuming it rotating forwards being displaced by the same angle, χ, in front of the current, that is, we may set it off along o v'. We now draw the polygon of E M.Fs. acting in the stator winding :—Stator current = 35·5 × 2 = 71 amperes ; leakage E.M.F. = $\frac{25}{9}$ × 71 = 197 volts ; this we set off as 39·5 mm. (o p) ; ohmic drop = 71 × ·5 = 35·5 volts ; this is represented by $p q$ (= 7·1 mm.).

Back E M.F. due to forward field = 500 volts and is represented by $q r$ (= 100 mm.), and lastly, back E.M.F. due to backward field = 150 volts, and is represented by $r s$ (= 30 mm.).

The supply E M.F. necessary will thus be o s = 769 volts.

We have consequently to reduce all vectors in the proportion 769 : 500 and obtain

Supply E.M.F	= 500 volts.
Stator current	= 46·3 amperes.
Power factor (= cos ϕ)	= ·615
Input	= 14·26 kw.
Stator C^2 R loss	= 1·07 kw.
Rotor current (forward wave) ...	= 107·5 amperes.
" " (backward wave)...	= 108·5
Rotor total C^2 R loss	= 0·785 kw.
Fixed losses	= 1·150 kw.
Total losses...	= 3·0 kw.
Output	= 15·1 B.H.P.
Efficiency	= 79 per cent.

As in the previous case we may calculate the input from the slip, and the rotor and stator losses thus :—

Rotor loss due to forward field = ·385 kw.

Power imparted to rotor by forward field is thus ·390 × $\frac{100}{3}$ = 13·0 kw.

Rotor loss due to backward field = ·395 kw.

Power imparted to rotor by backward field (the whole of which is turned into copper heating) is ·395 × $\frac{100}{197}$ = ·2 kw.

Stator C^2 R loss = 1·07 kw.*

Hence, input = 13·0 + ·2 + 1·07 = 14·27 kw.

Of the 13 kw. imparted to the rotor by the forward field 3 per cent., or more exactly ·385 kw., is wasted in C^2 R heating due to the forward rotor wave, but there is a further C^2 R loss due to the fact that the forward field is dragging the rotor against the backward field with a speed of 97 per cent. synchronism. This loss falls to

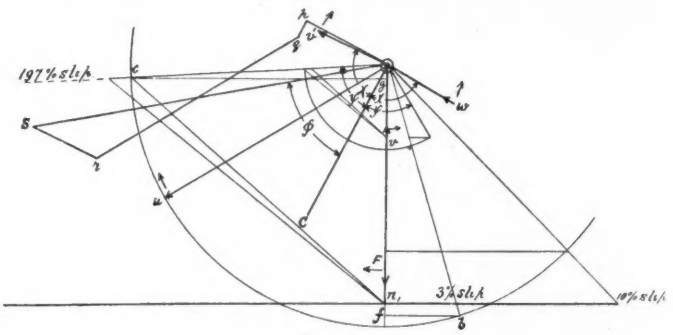


Fig. 12.

the account of the forward field and is equal to ·395 × $\frac{97}{197}$ = ·195 kw.*

The useful power developed by the rotor will thus be : 13·0 − (·385 + ·195 + 1·15) = 11·27 or 15·1 B.H.P.

This method of calculating the input from the slip and the losses is always useful as a check upon the diagram whereby the same may be arrived at by scaling off the power factor and stator current.

The Municipal Electrical Association.—This year's convention of the Municipal Electrical Association will be held at Bristol on June 14th, 15th and 16th, and the business meeting on June 17th.

* The rotor C^2 R loss due to the backward wave = ·395 kw., of this ·395 × $\frac{100}{197}$ falls to the account of the backward field, and represents the total power imparted to the rotor by the backward field rotating with a speed of 100 per cent. synchronism backwards, the remainder, or ·395 × $\frac{97}{197}$ must be charged to the account of the forward field, and represents the power lost in dragging rotor at speed of 97 per cent. synchronism against the backward torque which the backward field exerts.

ON A DIRECT CURRENT DYNAMO WITHOUT BRUSHES.

By ALBERT CAMPBELL, B.A.

It has often been laid down as a fundamental principle that it is impossible to construct a dynamo to give a unidirectional current without slipping contacts somewhere or other in the machine. And this principle seems reasonable enough when we consider the two possible cases that arise. In the first case a part of the circuit moves so as to go on cutting lines of force always in the same direction. As an example of this may be mentioned Lorenz's apparatus, in which a conducting disc is rotated in its own plane at right angles to a magnetic field. It is obvious that slipping contacts are here absolutely necessary. In the second case a part of the circuit (which we may call a coil) is so arranged that it becomes interlinked with a varying amount of magnetic flux. Now, every time the flux attains a maximum value the E.M.F. induced in the coil changes sign, and accordingly at that moment the coil must be commutated with regard to the main circuit, for if not we should obtain an alternating current. So in this second case *commutation* is essential, and therefore it would seem that slipping contacts must be used here also. But this does not follow, for, as I now proceed to show, commutation can be obtained without any sliding contact whatever, and with all parts of the conducting circuit quite rigidly connected together.

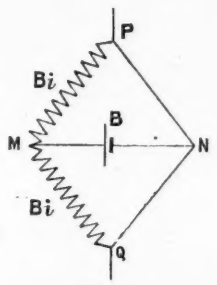


Fig. 1.

Let P M Q N in fig. 1 be a Wheatstone's bridge in which B is a battery or other source of continuous current, and let the four arms be of equal non-inductive resistance, but two of them, P M and M Q, of pure bismuth.

Since the bridge is balanced, there will be no potential difference between P and Q. Now let a strong magnetic field cut alternately the two bismuth arms. When either arm is in the field its resistance is largely increased, and the bridge

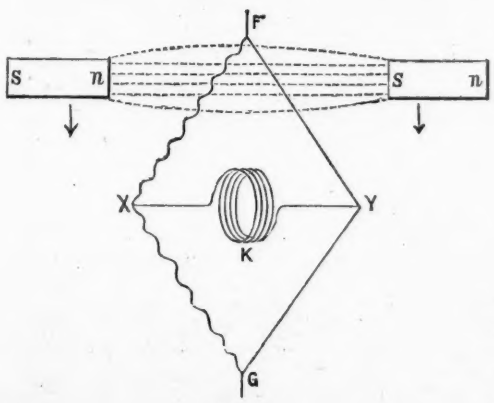


Fig. 2.

is thrown out of balance; we thus obtain an alternating potential difference from P to Q. From this simple case we can easily pass to the converse one where a source of alternating E.M.F. is made to give a unidirectional current.

This case is shown in fig. 2, in which the bridge arms are the same as in fig. 1, but the battery is replaced by a coil, K, with its plane perpendicular to the plane of the paper. If the magnetic flux shown in the figures now move downwards from F to G, and be followed at a distance equal to F G by a series of similar fluxes, an alternating E.M.F. will be set up in the coil, K. Owing to the action of the bismuth arms, however, a unidirectional difference of potential will be produced from F to G, and a rectified current may be taken from these points. To obtain a uniform continuous current it would only be necessary to connect in series a sufficient number of such elements as shown in fig. 3, and so to dispose

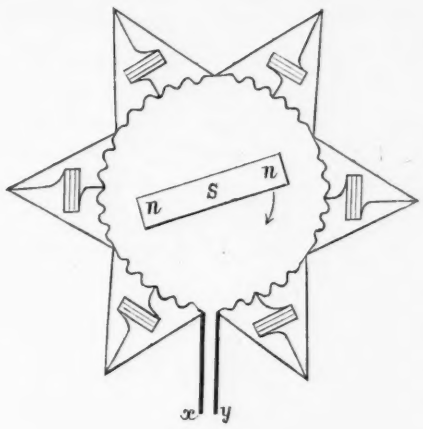


Fig. 3.

the rotating magnets that the pulsating E.M.Fs. produced by the several elements should be progressively out of phase with one another, and so produce a steady potential difference at x y.

To get more efficient commutation, all four bridge arms should be of bismuth, and they should be placed as in fig. 4, so that pairs of opposite arms may be in the magnetic field at the same time.

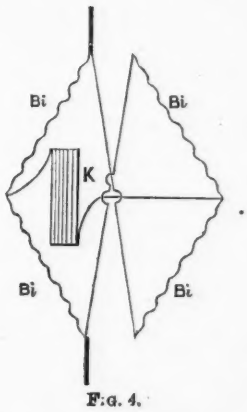


Fig. 4.

Let us now consider whether it is possible to obtain really efficient commutation in this way. If the bridge arms are of pure electrolytic bismuth at ordinary temperatures, a flux-density of about 14,000 would alter their resistances by about 60 per cent. In the most favourable case, where the coil, K (fig. 2), is of negligible resistance, the rectified voltage available from F to G would, for B = 14,000, be less than one-fourth of the alternating E.M.F. induced in the coil. If very low temperatures could be used the available fraction would be much larger, for the resistance changes in the bismuth would then be enormously increased.

The peculiar properties of bismuth in a somewhat similar way afford a means of obtaining rectified current from an alternating one without the use of moving circuits. In fig. 5 is shown a simple arrangement which gives a partially rectified current.

A strong permament magnet is placed with one pole close to one of the poles of an electro-magnet, E m, excited by an alternating current from A. A bismuth strip, B i, through

which this current also passes, is placed between the facing poles, and in parallel with the strip is a circuit consisting of a choking coil of low resistance and a moving coil galvanometer, G. If the permanent magnet is strong enough, the

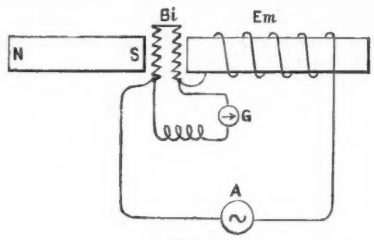


Fig. 5.

magnetic flux through the bismuth strip never changes sign, and the strip will have a higher resistance for one half of the alternating current wave than for the other, the result being that a partially rectified current will be sent into the galvanometer circuit. Even with ordinary commercial bismuth in which the resistance changes are relatively small, it is easy to get a deflection on the galvanometer which changes in direction when the permanent magnet N S has its position reversed. The choking coil serves to keep back much of the alternating component. This action of an impedance coil upon a pulsating current is worth a little further consideration. Fig. 6 illustrates the effect of increasing the impedance of a circuit of fixed resistance which has a constant pulsating P.D. at its ends.

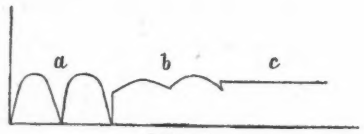


Fig. 6.

The curve, *a*, represents the current when the circuit is non-inductive, *b* shows the ripples partially smoothed out by adding moderate self-inductance, while *c* shows the result of adding very high inductance, namely, a practically continuous current. It should be noticed that the continuous current obtained is exactly equal to the mean value of the original pulsating current, although the values of their mean squares would be very different. The above experiment is an instructive one, and the result shows that in some practical cases impedance may be increased with advantage. Doubtless when rectified currents are used for arc lighting, the series coils in the lamps help to smooth out the current ripples and lessen the flickering effect noticeable at the lower frequencies. Unfortunately, however, it is the high frequency ripples that are most easily smoothed out.

The arrangement shown in fig. 5 does not give purely unidirectional currents, but these may be obtained from alternating ones by applying the principle there used to one or more of the arms of a Wheatstone's bridge.

Although these methods of rectifying alternating currents are probably of little use in commercial applications, owing to their low efficiency, it is possible that they may prove useful in connection with the measurement of certain alternating current quantities; in any case they form instructive lecture room experiments.

It is easy to see that in the arrangement shown in fig. 3, instead of using bismuth, copper wires might be employed, which should have their resistances varied by a gas flame rotating with the same speed as the magnet.*

To return, in conclusion, to our main proposition, it is evident that commutation can be obtained without slipping contacts, *i.e.*, in absolutely fixed circuits, by means of alterations in resistance produced by magnetic, thermal, or other means.

* As I have only discussed circuits with fixed rigid conductors, I have omitted all mention of electrolytic methods of rectifying alternating currents.

CALLENDAR'S ELECTRICAL RECORDING APPARATUS.

We have received recently a descriptive pamphlet and photographs of a very interesting piece of apparatus designed by Prof. Hugh Callendar, F.R.S., and constructed by the Cambridge Scientific Instrument Company, and we have seen it in action in Prof. Callendar's laboratory in University College.

The idea of the action is to arrange the contact on the scale wire of a bridge or potentiometer, so that the adjustment is made automatically. To do this the galvanoscope, which is usually employed to show which way the slider is to be moved in order to obtain a balance, is replaced by a contact making relay, and this causes a motor to shift the slider in one direction or the other, according to the direction of the current in the relay. A pen carried by the slider records its movement on a revolving drum, and a small planimeter continuously integrates the record. Fig. 1

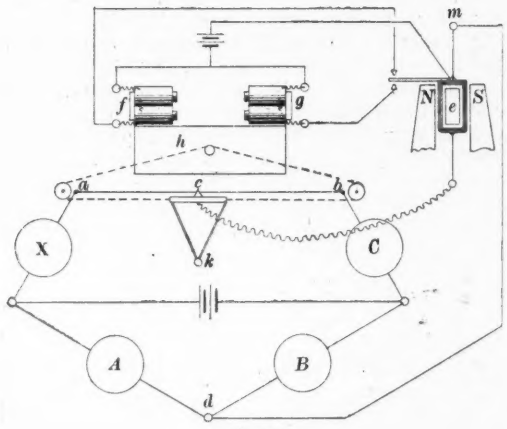


Fig. 1.

shows diagrammatically the arrangement of the apparatus when connected as a Wheatstone's bridge; *a b* is the wire and *c* the sliding contact. A B are the two equal bridge coils, C a fixed resistance nearly equal to X, the resistance whose changes are being recorded. In what is usually the galvanometer circuit, *i.e.*, between *c d*, is placed a contact maker, *e*, which by means of the electro-magnets, *f g*, regulates the movement of the clock, *h*, connected by a fine cord to *e*, in such a way that *e* always finds a point which is at the same potential as *d*, and the movements of the slider are directly proportional to the changes in the resistance of X.

The wire, *a b*, may be the scale wire of a potentiometer, in which case the movement of *k* records the changes of potential of any point connected to the other side, *m*, of the contact maker. Thus the instrument gives a continuous trace, showing on a scale of equal divisions the changes in the value either of the electrical resistance of a conductor, or of the potential of any object. The regular movement of the pen over the paper is unaffected by the weight or friction of the moving parts, and the action is free from the difficulties of instruments in which the small currents actually move the pen, as in the ordinary recording voltmeters and syphon recorders. The calibration of the apparatus is dependent only on the resistances of continuous wires, and the calibration of these quantities is capable of an accuracy exceeding that of any other physical quantity, with the the exception, perhaps, of mass and length. The indications of the instrument are unaffected by the contact resistance of the slide.

The immediate limitation of the accuracy of the record is the sensitiveness of the contact making relay, and it is clear that on this rests the efficiency of the whole. The relay used by Prof. Callendar is a suspended coil carrying a long light lever with a fork at the end between the prongs of which runs a wheel with a platinum edge, driven continuously by clockwork. A current through the coil of 4 micro-amperes will product an effective contact. The coil has a resistance

of 10 ohms, and the action is produced by an expenditure of $16 \cdot 10^{-11}$ watt in the coil.

To give an idea of what this means we may remark that a standard relay may be made to work with $2 \cdot 10^{-6}$ watt, and Mr. Evershed's instrument works with alternating current with about 10^{-10} watt. In practice these recording instruments, working on a bridge as in fig. 1, will continuously record the value of a changing resistance within $\frac{1}{2000}$th part of its value, or the value of a potential within $\frac{1}{25000}$th of a volt, and it is not necessary to say more to show what a powerful instrument for observation this affords.

Fig. 2 is an illustration of one of the instruments. In their present form they appear to be perfectly efficient and very well constructed, but with the extended use they are likely to find, we think they will be simplified in some of the mechanical

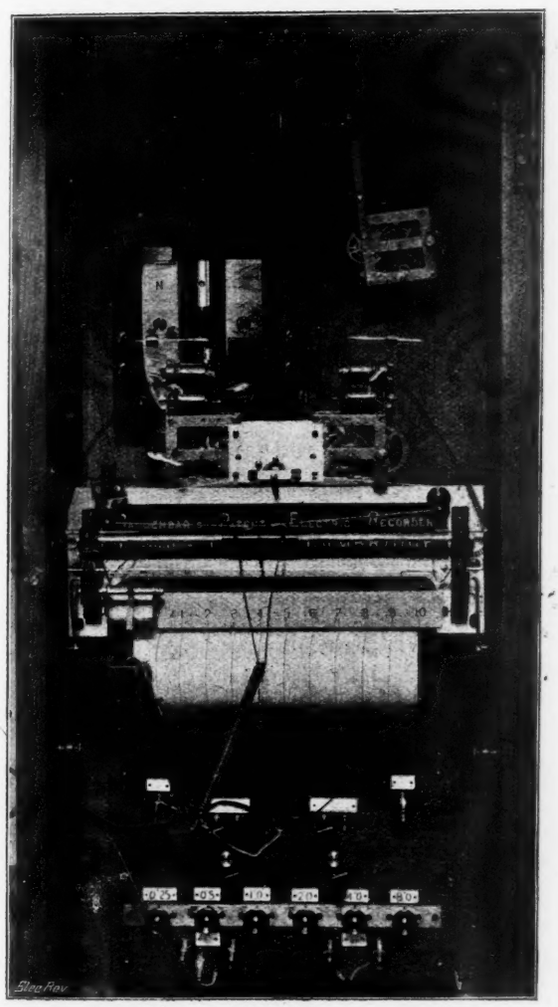


Fig. 2.

arrangements. A very large number of applications have already been proposed by Prof. Callendar, and may be indefinitely increased. We saw the instrument at University College recording sunshine by the difference in the resistances of two coils, one exposed to, one shielded from, the sun's light, and the record showed every passing whiff of cloud, and the pen was constantly moving backwards and forwards through small distances, even when no change occurred in the sunlight that was perceptible to the eye. In this particular instrument the slider, besides carrying a pen, was attached to the pointer of a planimeter rolling on the paper cylinder, and by this the actual amount of heat falling on the exposed coil, was automatically integrated. Curves of the discharge of a small storage cell, and of the output of a large generating station of 1,250 kilowatts, have been published. That one instrument should be able to deal equally with such different quantities as this last, and the light obscured by a cloud, is very striking. The instrument may be used to record nearly all electrical quantities, all temperatures, many of the meteorological observations, cyclical changes in steam engines and alternating currents, barometric and steam pressure, and for many other purposes. It is likely to prove to be an appliance of very great value.

WIRELESS TELEGRAPHY.

By RANKIN KENNEDY.

So-called; but it is not wireless. The long vertical wire is a leading feature in transmission electro-magnetic force to a distance. I would venture to make a simple explanation of the action of this transmitting of force from one vertical wire to another at a distance, believing, as I do, that it can be easily and clearly explained on the ordinary, well-established electrical and magnetic principles so well known to most people interested in electro-magnetic work.

It is not necessary to go back to the Hertz theories. These have not yet been established, nor can they be until someone proves that the Hertzian waves vibrate at right angles to the line of their propagation, like light waves are supposed to do. Sound waves can be reflected, refracted, and detected by means analogous to those used to reflect, refract, and detect light or Hertzian waves, and we know that the sound waves don't vibrate in planes at right angles to their propagation lines.

It will be time enough to drag in the Hertzian theories when ordinary accepted theories fail to account for the effects.

There are only two electrical inductive effects known to electricians, electrostatic and electro-magnetic, the latter represented by lines of force forming closed circuits. Both of them can act through air, non-conductors and conductors, hence it requires no wire to connect two places, from one of which we desire to act inductively on the other.

Theoretically we should be able to induce an electric current in an instrument in New York by manipulating another primary current in London or Hong Kong, without any wire connection or cable. Practically there are some slight difficulties, such as the curvature of the earth, and the length of the vertical wires requisite, and if we were telegraphing secret messages, they could be read by anyone with a vertical wire and an electric bell outfit.

Attempts were made first to induce currents at a distance by what may be called the coil or loop method, and this is still under investigation by a very eminent professor.

It is a method doomed to failure at comparatively short distances for two simple reasons.

The science of vertical wire telegraphy is the same as that of the common transformer or induction coil, and so is the science of the loop or coil telegraphy. In the latter case we set up a primary coil at A, and at B a secondary coil, where we wish to receive messages from A; the space between is the magnetic circuit, a bit longer than usual in transformers and a good deal larger in cross sectional area than in iron-cored transformers; a circuit about as long as Liverpool, and as great in area has been used.

The simplest coil is a single turn or loop ∩; if we set up two coils ∩∩ and generate alternating currents in one, an alternating current will be set up in the other, and if the magnetic circuit is of low resistance and the one loop equal to the other, the induced E.M.Fs. will be equal to the inducing E.M.F. in the primary loop, always provided the whole of the induced magnetic flux passes through both loops.

Now the E.M.F. generated in a coil of wire through which the induction varies is equal to the product of the number of turns multiplied by the rate of change of magnetic flux density. Expressed by Mr. Weeks as

$$E = 4 \cdot 45 \, F \, r \, n \, 10^{-8}.$$

F is the total flux, r the number of turns in the coil, n the frequency of alternations, 10^{-} to reduce to volts.

Now, in a transformer with the primary a few miles from the secondary loop the amount of the magnetic flux which reaches the secondary cannot be much more than a very small fraction of the whole, and the fraction which does reach it is not all effective, for it cuts both sides of the coil in the same direction, partially neutralising each other.

4·45 is constant in value, F is naturally exceedingly small, r, for reason to be seen presently, cannot be more than one turn, or, better still, as Marconi has it, should be half a turn, the only factor left us to increase, to keep up the induction at a great distance, is n, the frequency $\sim$. The higher the frequency the greater the distance we can operate.

Now high frequency cannot be worked through loops and coils. For at quite limited frequency a loop or coil opposes enormous resistances against high frequency E.M.F., and the current passing is reduced to almost zero. And as F depends on current value, we soon reach a frequency, at which any further increase is counteracted by the decrease in current, even in a single loop, *vide* Tesla's results.

For these reasons the loop or coil method is limited to low frequency, and consequently short distances.

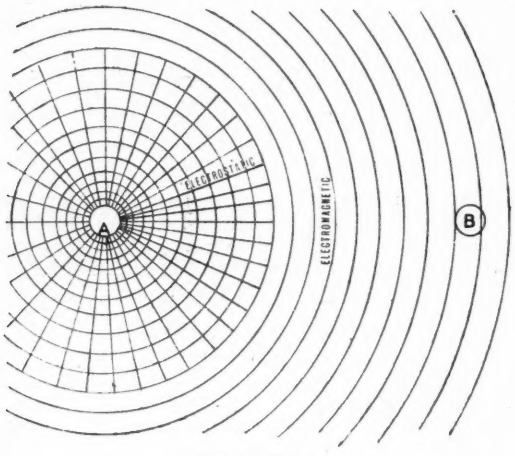


Fig. 1.—Plan.

Naturally one at once says: "But we must have a loop to procure a *current;* it must go in one end and out the other;" that is so, for continuous currents these must have on outgoing and return, a complete circuit.

But alternating currents can be sent up and down a single wire with no metallic return. All we require is a capacity at the top of a vertical wire, and an alternating charging + and −, or + and o *zero* at the lower end; every charge at the lower end rushes up the wire as an electric current and charges the ball, or capacity at the top, when the charge at the lower end is discharged or reversed, a current rushes down from the capacity ball at the top. Here we have an alternating current produced in a single wire, and it is this current which induces, F, magnetic force waves to act on the distant wire.

The reason why the wire must be long is that length takes the place of r in the formulæ, that is, instead of terms we would take d, the length in centimetres or feet.

Both electrostatic and electro-magnetic induction takes place in setting up currents in a single wire.

Fig. 1 is a plan of two wires vertical, fig. 2 is an elevation of the same.

In fig. 2 the electrostatic lines are curves proceeding from the capacity, C, to earth, hence the earth connection of the one pole of generator; the electro-magnetic force travels in horizontal circles and cuts the distant conductor. In fig. 1 the electrostatic lines are radial, they don't act inductively on the distant wire, but only act in producing the primary alternating current, a local effect concerned only in the alternating current production in a single wire.

With high frequency the inductive effects near a single wire are startling and interesting.

The spark discharge has been looked upon as an essential in single vertical wire telegraphy, but it is not so, it is used simply because it is at present the simplest and most effective method of producing very high frequency charges and discharges, the induction magnetic flux from the spark itself is in the form of a thin disc, the axis of which is the spark, the spark acts for the instant of its duration as a current.

Other methods of producing high frequency currents in a single wire will occur to many electricians. The sending

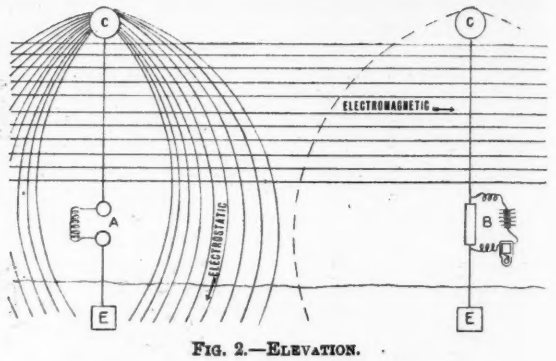


Fig. 2.—Elevation.

and receiving wires are simply the primary and secondary of a transformer. The currents produced in the secondary are too minute, and of too high a frequency to be received in any magnetic or electric instruments; but, luckily for vertical wire telegraphy, Branly invented his coherer. This simple apparatus makes an excellent relay, and has been adopted in all the long-distance work—an impossibility without it.

There is no mystery about the long wire vertical; the mystery is, why should anyone use a loop and low frequency?

The new Wehnelt interrupter and improved spark-producing apparatus may make great advances in the near future.

It seems to the writer very strange, that nothing better than the rude, inefficient induction coil of 50 years ago should be the thing used for the high frequency current generating apparatus.

They may be very simple, but they are costly and not durable machines in everyday constant use.

If the wire is horizontal, there is little or no effect, probably because of the inductive effects of the earth, through which one-half of the magnetic flux would pass, the electrostatic induction would also be disturbed by the proximity of the earth to a horizontal wire.

The question is, what is the limit to be placed on the frequency of the current in the vertical wire, and what is its impedance to high frequencies?

No part of a single wire can be cut by its own magnetic flux. With a loop the flux from one side cuts across the wire on the other side, causing much impedance with high frequency.

ELECTRIC RAILWAYS.

By E. KILBURN SCOTT.

At the Society of Arts on Wednesday, the 22nd ult., Mr. Dawson attempted, somewhat summarily, to dismiss electric traction by polyphase motors, a procedure which, judging from the remarks made in the discussion, was considered rather unfair to this recent development of electric traction.

The lines at present working with three-phase currents throughout are the Lugano tramway, the Gornergrat, Jungfrau, and Engelberg Railways, and a small line at Evian-les-Bains; but there is already sufficient evidence that the system has a very great future before it, and it will be a great pity if the Metropolitan Railway Company does not give polyphase motors a trial. They are supposed to be experimenting.

Now that the question of torque is settled by the fact that trains are mounting grades of 25 per cent., the only point left for criticism is the question of control. One can understand that in ordinary street tramway work, where the car may be started and stopped at intervals of a couple of hundred feet or so, series paralleling shows to great advan-

tage; but a *railway* is so called because it has stated stopping places or stations, which may be several miles apart, and are seldom less than, say, 2,000 feet. It is a debatable point whether this is a short distance from the point of view of series parallel control. The writer thinks it is not.

The shortest distance betweeen stations on the Metropolitan line appears to be between Mansion House-Cannon Street and Cannon Street-Monument, each about 1,000 feet. The average of 15 other stations is 2,250 feet, and on the rest of the system they are 4,500 feet or more apart. Out West, and towards the suburbs generally the distances become much greater.

These distances compare favourably with other lines worked electrically, yet we find that the motors on the Liverpool Overhead Railway are always in parallel, and the motors on the City and South London are always in series, without the current being wastefully used in either case, or there being any particular difficulty in accelerating properly. If trains on these railways were liable to be "held up" by passengers at any part of the line, say, a dozen times in half a mile, it would be a different matter altogether.

In replying, Mr. Dawson was anxious that he should not be accused of unduly pushing American methods, &c. In the early days of electric traction we did well, nay, we were obliged, whether we liked it or not, to follow American practice closely; now, however, that we have had lines running for some time and our manufacturers are able to turn out plant more promptly, it is time we began to think out these traction problems for ourselves.

Mr. Parshall has said that directly 4,000 horse-power is reached on any electric railway system it becomes absolutely necessary to use three-phase generating plant. Exactly, but why not use the alternating current throughout. When the electric railway makes real headway, 4,000 horse-power will be quite a small amount. Two of the New York power stations will be shortly equipped with about 30 such units. Just as we are adopting overhead electric traction *exclusively*, we find the authorities at Washington and New York so pleased with the electric conduit that they are extending it in all directions. Perhaps by the time our railways are given over to a combined three-phase and continuous current system, we shall find our friends across the Atlantic going in strong for three-phase working throughout.

Three-phase motors for traction should be given a trial in this country as soon as possible, for if there is anything in it we ought to be knowing at once.

MULTIPLE CIRCUIT DYNAMOS.

There has recently been described in the *American Electrician* a method of using multipolar dynamos having parallel wound armatures in which the brushes, instead of being connected to feed a single circuit, are connected independently to separate circuits, the voltage and current in each of which may be varied without reference to the others.

The method is due to Mr. S. N. Rushmore, and in the article to which we refer figures are given of a series of efficiency tests on a four-pole machine feeding two circuits at different voltage and current. The machine was shunt wound, the magnet coils being in two circuits corresponding to their respective pairs of brushes with regulating resistances for the purpose of varying the voltage. The general result of the tests appeared to show that such a method of connection was quite feasible.

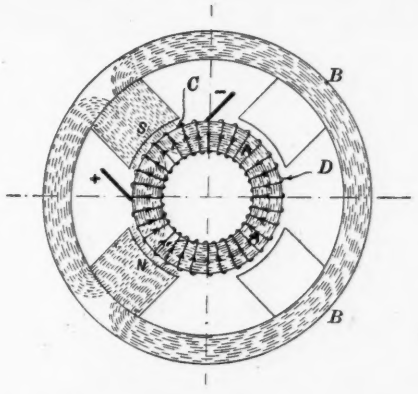
Let us see what takes place in a multipolar dynamo connected in this manner. The figure shows a four-pole machine in which one pair of magnet limbs are fully excited, while the others are not excited at all. The magnetic lines in the armature when they reach the points, A A, have two paths before them, they may either pass through the armature core from A to A, or they may pass through the right-hand air-gaps and limbs up to the yoke. The lines in the yoke similarly when they reach the point, B B, may either traverse the yoke from B to B, or they may pass through the limbs and air-gap to the armature. As the paths, A A and B B, have a reluctance which is practically negligible in comparison with the alternative route, the lines naturally take these paths and the magnetic distribution is as shown in the figure.

It is immaterial whether we employ a ring or drum armature, but in order to follow the course of the currents more readily we show a ring. When the machine is on open circuit we have the full voltage, say, 220 volts, on the left-hand brushes and nothing on the right-hand. Let us follow the path which a current would take as it entered the top brush. Here it would divide and pass through the circuit, C, which consists of a quadrant of active conductors, to the left-hand brush. The other portion would pass through the circuit, D, which consists of one quadrant of active conductors and two quadrants of inactive ones finally also arriving at the left-hand brush. As there are an equal number of active conductors in each circuit the voltage generated in each circuit will be equal. We see, then, that when the external circuit is closed and current caused to flow, the current, in its passage through the armature, will have to traverse two circuits of different resistance.

Each armature circuit will generate the same E.M.F., but in circuit C the current will traverse one quadrant only, while in circuit D it traverses three quadrants. As the terminal voltages must be equal, the currents in the two circuits must be different, their values being in inverse proportion to the resistance of their respective paths.

The current in the right-hand half of the armature will set up a slight field in the right-hand magnets, but the E.M.F. so generated will be in the same direction as the main E.M.F. in one portion, and counter to it in the other, so that its resultant effect will be *nil*.

As an example we will take the case of a four-pole machine, compound wound, having an output of 220 volts and 300 amperes, the armature resistance being ·020 ohm, shunt coils 18 ohms each, and series coils ·005 each. At full load the total volts generated will be 228 and the current 312



amperes. The current will be equally divided in the armature, so that there will be 78 amperes in each quadrant, and the watts loss in the armature will be 1,950. The electrical efficiency will be 92·8 per cent.

Now, suppose the machine to be idle on the right-hand side, with the left hand supplying 220 volts and 150 amperes to its circuit. The current will now take the two paths, C and D, and the amounts into which it will divide will be 117 and 39 amperes respectively. The watts loss in the armature will be 1,461, and the electrical efficiency of the machine will be 91·5 per cent.

These figures show that this lop-sided method of working need not seriously affect the efficiency of the machine, but it should be pointed out that there will be sparking unless the reversing field has been made strong enough to commutate a current of 117 amperes per conductor instead of the normal current of 78 amperes per conductor. There is another point to be considered, and that is the side pull upon the shaft due to the unbalanced magnetic forces. With an armature 21 inches diameter and 12 inches long, a gap density of 39,000 lines per square inch, and a polar angle of 60°, the resultant horizontal pull will be about 4,000 lbs. This would give a pressure on the bearing surfaces of about 50 lbs. per square inch, so that (so long as the shaft is strong enough to withstand deflection) in an emergency a four-pole machine may be run with one side idle and the other doing half the normal output of the machine. It is not necessary to investigate the case when both sides are working but

giving different outputs. We have shown that the extreme case is possible, and any intermediate case is, of course, also possible.

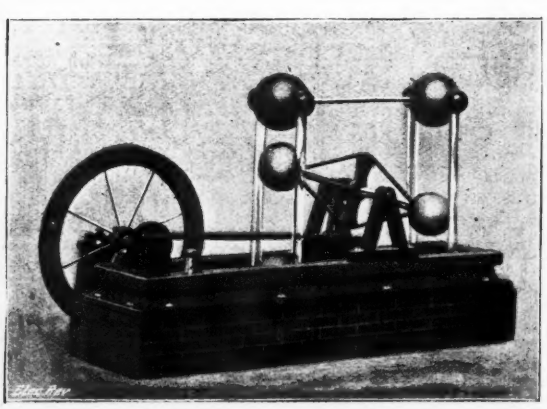
It is suggested in the article to which we have already referred, that a machine of this type would be very suitable for accumulator installations, as one side could be shunt-wound to give 135 volts, and the other compound wound to give 100 volts. Such a machine, however, would very seldom be called on to give current on both sides simultaneously. Generally, when the charging side was working, the other side would be idle, and *vice versâ*, so that the machine would work under its worst conditions. For such a purpose we consider an ordinary 100-volt machine, with a 35-volt booster, preferable. The system might, however, be used in connection with feeders, the length and losses in which vary. Thus a six-pole machine might supply independently three pairs of feeders, each requiring a different voltage supplied at its terminals, in order to maintain a constant voltage at the far end. The pair of magnet coils corresponding to each pair of feeders could be over-compounded to give the required voltage, and boosters and feeder boys might be dispensed with.

Possibly the idea may be worth the consideration of our central station engineers, and at any rate it could be easily tried.

INTERESTING STATIC MOTORS.*

By HOWARD B. DAILEY.

The amateur worker in static electricity who possesses a good influence machine finds himself equipped with a source of much instructive entertainment for himself and scientifically inclined friends. To the experimenter any piece of accessory apparatus having novelty of design is always a welcome acquisition. The experiments possible with a six or eight-plate Wimshurst machine, such as is described and illustrated in *Scientific American Supplement*, No. 584, are of endless variety, and, when aided by suitable accessories and manipulative skill, luminous effects of great brilliancy and exceeding beauty may be produced. Such manifestations naturally appeal chiefly to the eye, but not less interesting to the student of physics is that class of experiments dealing with the conversion of mechanical energy into electrical and back again into mechanical energy in a manner readily perceived by the eye at a glance.

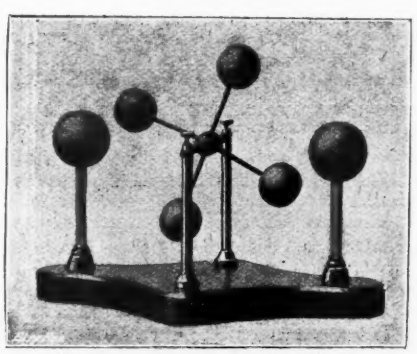


Static Electric Motor.—Reciprocating.
Fig. 1.

To demonstrate this principle, as well as to exhibit in a striking way the operation of electrical traction and repulsion, the writer has devised two forms of static electrical motors. Fig. 1 is a small horizontal engine. At the ends of a vulcanite lever or walking beam are two wooden balls covered with gold leaf to give them a conducting surface. These play up and down between upper and lower sets of stationary brass balls.

The two upper balls, which are in metallic connection with each other, are supported above the walking beam upon four perpendicular glass pillars and are connected with one of the conductors of a static machine. The lower balls, which are not insulated, are given an earth connection through a binding post in the ebony bed frame of the engine. As the upper balls become charged through the action of the machine, their attraction causes the nearest of the two movable balls to rise within striking distance, when it receives a spark, thus becoming itself electrified, and is immediately repelled downward to one of the earth connected balls, to which it yields up its charge. Being now in a neutral condition, it is again attracted upward. As the material separating the moving balls is an insulator, the action of each is independent of the other, one being repelled while the other is attracted. A reciprocating motion is thus given to the lever which is communicated to the fly-wheel shaft by means of a connecting rod and crank disc.

Since the attractive and repulsive force of static electricity is far from powerful, it is essential that machinery operated by it should be very light and freely running. To this end the moving balls, which are about 1½ inches in diameter, are made hollow and very thin, being turned in halves and glued together. The fly-wheel, which is of gilded wood, is very light and runs in pivoted bearings, as does the walking beam. This beautiful little machine, highly finished in all its parts, presents a very attractive appearance and runs at a rapid rate of speed; the click of the sparks as the swiftly flying balls charge and discharge themselves being strongly suggestive of the puffs of a steam engine. Watching the instrument in operation, an observer, unaware of the lightness of the moving parts, is impressed with the idea of considerable power, but is somewhat surprised to find that a sheet of notepaper standing upon edge and leaning at a slight angle against the rim of the fly-wheel soon brings it to rest. Fig. 2 is a simple rotary motor. Into the hub of a



Rotary Electric Motor.
Fig. 2.

horizontal spindle, whose indented ends receive pivot-pointed screws passing through the tops of two upright brass standards, are inserted four slender vulcanite rods carrying at their outer ends gilded wooden balls. At the opposite sides of the instrument and very near to the revolving balls are placed two larger balls of polished brass, supported upon glass rods and connected respectively with the opposite poles of a static machine. The current being turned on, attraction and repulsion cause a rapid rotation of the spindle.

This motor, from its continuous rotary action, is much the more powerful of the two, and has about it a sensitiveness and life that is wonderfully taking, while its appearance in the dark is highly interesting. Both these instruments run very satisfactorily either from a small influence machine or an ordinary frictional machine, furnishing an excellent illustration of the reappearance as mechanical energy of part of the power applied to the static generator after having been transformed largely into electrical energy.

* *Scientific American.*

THE POST OFFICE AND TELEPHONY.

By A STUDENT OF THE PROBLEM.

When a pioneer in the electrical industry like my revered friend, Mr. S. A. Varley, approaches a subject with "the sole object of bringing home to the British public the evil consequences of converting applied science into a Government trading monopoly," it may seem ungracious to criticise the articles which he has contributed to your columns, but when the immediate object is to awaken the Legislature to the advantages of free trade for telephony, telegraphy, and the carriage of letters, there may be some excuse for a rejoinder. Eminent economists have shown how much better it would have been to undertake postal service by private effort, but the conveyance of letters by a Government Department exists, and there is no danger of the Legislature modifying the conditions. The telegraphs are now under similar control, and whatever may be said to the contrary, are so generally recognised as being in good hands that they are likely to remain there. The subject which the Legislature has to seriously consider is the position which is to be assigned to telephony. Mr. Varley, like most of us, is impressed with the benefits of competition. It is so pleasant to see competitors cut their throats for our benefit, and it is so comforting to reflect that all the time the competitors themselves are being forced by circumstances to devise improvements and to put forth the full strength of their thews and sinews to exist. The advantages of competition as they appear to us most closely are great, and it is not surprising that we should forget that they are sometimes dearly purchased, if we are not indeed disposed to give credit to competition for results which have been obtained by its absence. I quite agree with Mr. Varley that a comparison of the railway and telephone development is to the disadvantage of the latter, but it does not lead me to the same conclusion. One great element in the development of the railway system was the granting of a monopoly to the pioneers. They put down their money and they obtained or lost their Act as the case may be, but if they obtained it they had the assurance that so long as they complied with certain provisions, and the necessities of the district did not require it there would be no possibility of a competitor running a line alongside theirs. It was the much-abused monopoly which gave us our great trunk lines and started the railway organisation. The Telephone Company was treated differently because the conditions were different. The Bill for the purchase of the telegraphs "introduced by a Disraelian Government," was happily completed by "a Gladstonian-John Bright cabinet," who took care to protect the interests of the country by inserting a clause which ensured that they were not paying for something which might be valueless next day. Mr. Varley says that the telephone was outside the provisions of the Telegraph Act. The Telephone Company said so too, but then, unfortunately, the Judges said the reverse. Mr. Varley attributes the decision to "the command of leading scientists as special pleaders," but surely such leading scientists as Lord Kelvin and Sir Frederick Bramwell were on the side of the Telephone Company. "The Law is a hass" no doubt, but the decisions of legal tribunals are not to be gainsaid. Hence the Telephone Company could not be a sovereign. It had to be content to be a vassal and to pay tribute to its sovereign. It need not have gone on with its work, but happily it consented to do so on the terms proposed. There were others who sought to reap the benefits of competition, but the Telephone Company had patents. The patents became the subject of legal decisions. There are many who thought again that "the law is a hass," but nevertheless the law had to be obeyed. Hence the Telephone Company had practically a monopoly until the expiry of its patents made it possible for others to work, and then there seemed some chance that an object lesson might have been gained, but with the help of much talk by the promoters and a little wool from Parliament a combination of forces was ensured. Had the combination not been effected the "blessings" of competition in telephone exchange work might have been demonstrated in practice. As the combination was effected there has been no opportunity of bringing home the disadvantages, and every opportunity of enlarging upon the supposed advantages of such competition. That Mr. Hanbury should see advantages in competition is not surprising. He has excellent reasons for it. That Parliament and public should see advantages in it is not surprising either. They have excellent reasons too, though perhaps not exactly the same. To compare competition in telephone exchange work with competition in other branches of applied science or trade is to compare different things. You have so often insisted on the importance of unity in system and control that there is no occasion for me to go over the ground. But the concentration of this control in a Government Department troubles Mr. Varley. Why? Because of the dominating influence which it gives to individuals, which influence may be used to the detriment of inventors personally, and the science to which they are attached generally. The mental attitude of inventors is not readily comprehended. Their range of vision is wide, and the consequences which result from a disposition to carefully estimate independently the value of their inventions is liable to be seriously distorted by them. The instances which Mr. Varley gives of the action of Postal authorities in their own domain seems to show a catholicity of view which confirms the very general impression that any useful invention is not only adopted, but improved by the experience of the Postal Department.

The dominating influence on electro-dynamics generally, which Mr. Varley sees is not observable to others, though there are undoubtedly numbers of people who consider that their inventions ought to have received more attention. So long as there are inventors and so long as there are authorities who have to determine the adoption or rejection of more or less new ideas it is inevitable that there must be disappointment and dissatisfaction. Such an argument to support an attitude of free trade in telephones has no weight. The telephone must be a monopoly, and in England a monopoly should be Governmental. The Civil Service of England stands higher perhaps than any in the world, and those who have come in contact with the officials of a Government Department, are almost without exception impressed with the ability of its officers, and the way in which they identify themselves with the work to be done. Whether the Government should be allowed to compete with the company or buy them up is just the question which it seems to me the Legislature should be called upon to determine. I quite agree with Mr. Varley that the Post Office should not be allowed to confiscate the Telephone Company's property. There should be no occasion for it. Let it be recognised that the Government is the proper authority to undertake the working of the telephone, and it becomes only a question whether it should begin *de novo* or acquire the existing works. A solution is to be found in the avoidance of competition.

THE COST OF SUPPLY TO SINGLE-PHASE ALTERNATING MOTORS.

There are some aspects of the question of supplying a motor load upon single-phase alternating current circuits, which although they have as yet undergone little or no discussion among central station engineers, are beginning to have a decided and pressing interest. In pointing out the salient facts of a question which will certainly require solution in the near future, we may leave aside all discussion as to the relative merits of continuous and alternating currents, single and polyphase, for the supply of motors, and consider only that there are in this country many single-phase alternating current systems in towns where the motor output, even when fully developed, may very possibly never become more than a half of that for lighting; that in such cases the engineer cannot boldly lay down a continuous current network for power alone, but simply has to make the best of the material to hand; and that a motor load is generally believed to be desirable, if only for its effect upon the load factor of the station.

Single-phase motors as now made are simple, efficient, and reliable in a high degree, and in these respects compare very favourably with the continuous current motor. Their

drawbacks—which appear to be inherent in the type and not likely to yield to improved methods of design—are that for a given starting current their starting torque is very small, necessitating the use of loose pulleys and striking gear, and their low power factor. The first mentioned fault does not greatly affect the station engineer, but is rather the affair of the user who has to make arrangements for putting the load on gradually. The second, however, affects him largely. In the descriptive pamphlet of instructions which the manufacturer sends out with the motor, the power factor characteristics of the motor are popularly explained as a slight but necessary evil, and it is carefully pointed out that the user must see to it that he be supplied with a true watt-meter, as otherwise he will be charged for more energy than he actually uses. He therefore does so, and is so supplied.

As long as the motor load consists of a dozen or so of small rating, driving ventilating fans, barbers' brushes, and sausage machines, the matter is of no moment. In many towns, however, these motors are largely used in printing works, for driving shafting in workshops, for pumping, and so on, their aggregate horse-power running into many hundreds. When this is the case there can be no doubt that an appreciable loss to the supply undertaking results from charging for the energy consumed on the true watt basis.

Nearly all the items which go to make up the total cost of a unit sold are affected adversely by a low power factor. Considering only the effect upon the capital cost of the generating, transforming and distributing plant produced by a reduction of the power factor from unity to ·5, it is obvious that, allowing the same percentage loss in working, the section of copper in generating machines, high and low tension mains and transformers must be doubled, or else higher working losses must be permitted throughout the system.

It is, of course, true in most cases that the major part of the motor load is supplied during daylight hours when the mains and transformers are otherwise lightly loaded, and that very few stations are likely to have anything like so low a power factor as ·5 at full load. But it must be borne in mind that during the winter months the motor load certainly overlaps the lighting load by two hours or more, and that, in any case, allowance has to be made in mains and transformers for each individual motor to run during the hours of full lighting load. Further, assuming the greater part of the load to be made up of small and medium sized motors, many of which will be running light or but partially loaded, it is unlikely that the average power factor at the station would be as high as ·5.

In any case it is unfair that the extra cost of supplying an inductive load should fall equally on all consumers, irrespective of the nature of their demand, which is what happens when the ordinary rate—that is for true watts used—is charged, for in all cases, to charge the user of a motor by the reading of a true wattmeter is to secure a smaller return for capital sunk than that brought in by the ordinary consumer.

On the other hand, to charge by the reading of an ampere-hour meter, besides being unfair, would certainly have the effect of stifling in its infancy what promises to become a considerable source of revenue. Possibly an approximation to a fair charge would be to take the mean of the units recorded on an ampere-hour meter and those recorded on a wattmeter in series with the former. In the case of the ordinary small consumer, however, the cost of the additional meter or similar device would go far towards neutralising any advantage otherwise accruing. It is, therefore, not easy to suggest how the difficulty is to be overcome, but as it is certain to come into considerable prominence in the near future it is to be hoped that it will shortly undergo authoritative discussion.

CORRESPONDENCE.

Temperature Correction Tables.

An article in your issue for March 31st presents us with a new empirical formula developed by Messrs. Clark, Forde, and Taylor, for the temperature-correction of the electrical resistance of copper. This formula involves two coefficients, corresponding respectively to the first and second powers of the temperature-differences. Under ordinary circumstances, such a formula would be too complex, but I understand from your article that the results have been worked out and tabulated for each degree of temperature within a useful range, so that subsequent application of the formula to practice is a very simple operation.

Your comparative table of figures, calculated from formulæ new and old, exhibits the Clark, Forde & Taylor coefficients to great advantage, fully justifying your opinion, with which I concur, that where Matthiessen's table is still used it should be replaced by these new tables. But I venture to think that your comparative table is scarcely generous towards the logarithmic law. In line D you give the figures "calculated from a logarithmic law" from the values at 32° and 72°, and similarly in line E those calculated from the values at 32° and 100°; your article describes them as "much inferior" to those derived from the straight-line law. It looks rather as though there was some small error in the choice of the logarithmic rate of interest. I have found it a good plan, in such cases, to take the arithmetic mean of all the rates calculated from every pair of alternate observation points throughout the "observed" curve. Messrs. Clark, Forde & Taylor at D and E have probably taken only the first and last points on the "observation" curve.

I entirely agree with you that "the straight-line law," so far as copper is concerned, is "amply good enough" for cable work. The appropriate straight-line law will never lead to errors greater than those due to our ignorance of the real temperature of the cable, and the variables of the measuring apparatus as usually arranged. The logarithmic law has the advantage that the calculations for "copper" and "dielectric" are of the same form with one another; the logarithmic tables are consistent and simple in construction. But, personally, I prefer to spend the law-seeking time upon ensuring the accuracy of the direct observations. The *observed* results—not those calculated from an arbitrary law—are then plotted, and the length of ordinate corresponding to standard temperature is measured on the "observed" curve. With a slide-rule, the ordinates corresponding to every other degree of temperature are divided in succession by this standard ordinate. Thus, in a few minutes, the required multipliers are obtained, and the consideration of arbitrary formula is left to those whose pleasure it is to "soar away on the wings of extrapolation."

The redeeming merit of Messrs. Clark, Forde and Taylor's "law" is that it precisely fits the *observed* figures between their own limits of direct measurement; the tables themselves are therefore beyond criticism, but a similar result might have been obtained by a simpler "law," or even without a "law."

Rollo Appleyard.

April 4th, 1899.

Six Wheels for Electric Carriages.

In your interesting account of the Joel electric carriage in to-day's issue, you refer to the difficulty of designing a motor carriage that does not require a horse to complete the effect.

The difficulty may, perhaps, be got over by the introduction of *six* wheels in place of the horse-drawn *four*, as in a design recently published by me for a heavy steam freight car. The motors would then act on the centre pair of wheels, the two other pairs being steerers connected together so as to turn equally in opposite directions.

In this way much more battery space would be available, while the extra wheels would prevent the increase of weight from manifesting itself is a greater tendency to sink in soft places. The driving wheels, as carrying a larger proportion of the load, should no doubt be rather broader than the others, but the wheels should all be of *equal* diameter so as to be comfortably stowed away *below* the carriage body. Railway carriages were first hung *between* the wheels like ordinary coaches, and we may, perhaps, take a lesson from their development to present arrangement.

Alfred J. Allen.

London Institution, E.C.
April 7th.

The Absolute Block System of Signalling on Railways.

In yours of 7th inst., Mr. C. E. Stretton says his attention has been directed to a letter by Mr. Christopher J. Little. It was Mr. Stretton who directed my attention to your journal *re* the above, so that he did not require any person to direct his attention to my letter.

He states that the absolute block system was in use many years before 1865, and that he remembers it in use on the Midland Railways (he leaves out the date when he first saw it in use), the date he put in the papers some nine years ago, was 1860, he was at that time only 15 years of age; but the system of signalling has been altered since that date, and, therefore, Mr. C. E. Stretton is something like 40 years behind the times. Forty years ago there were no starting signal fixed, "line clear" was then given when a train passed the home signal; at the present time a train must pass the starting signal before "line clear" must be given.

He further states that the Government some years ago investigated my case, and found that my claim was not founded on fact. This statement is absolutely groundless, as no letters from the Government to that effect has been received by me or by Mr. Stretton.

I have not only a claim against the Government, but also against his friends, the great signal manufacturers, Messrs. Saxby & Farmer, as I sent it to them, 1866, and they have worked my system ever since; I considered I was entitled to some commission for having introduced the "absolute block system" to them. In 1887 Mr. C. E. Stretton wrote an important letter in *Iron* about Saxby & Farmer's patent "absolute block system," and Mr. Stretton would not be aware at that time that I was the inventor of the patent.

Christopher J. Little, M.S.A.

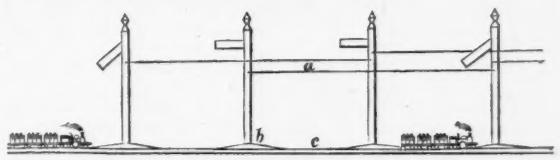
In your journal, March 31st, Mr. F. W. Cooke refers to my claim against the Government as the inventor of the absolute block system of signalling on railways. My claim is in accordance with a circular sent me by the the Prime Minister, 1870; and also in accordance with a circular sent me in 1886 in answer to my letter, "What was required by the Government for working the railway traffic in the United Kingdom?"

The circular stated that an "interval of space" must be kept between following trains; no mention is made about the electrical instruments; therefore two stop signals must be kept at danger behind all trains, and as I published that system in 1865, I claim to be the inventor. When it was stated in the papers, 1865, that it was impossible to work the railway traffic in foggy weather without collision, Sir W. Cooke and all the inventors, patentees of railway signalling, and railway signalling manufacturers, were alive, but could not find out a system of signalling to make it possible to work the railway traffic. I was at that time an apprentice on the Great Western Railway; it must therefore be very humiliating to those scientific gentlemen, to think that an apprentice on the railway should know more than the managers of the great railways, and the signal manufacturers and patentees, how to work the railway traffic with safety in foggy weather without collision.

Mr. Cooke refers to the permissive block system, that is, he states, like the rest of the writers upon the subject, *i.e.*, "that in which two or more trains are allowed in the same section this, as Mr. Little states, is not the absolute block system, but it *is* nevertheless in use." This statement is absolutely incorrect, and it appears to me to be copied from the authors of "Railway Block Signalling," and therefore Mr. Cooke does not understand the present system of "absolute block system," or he would not term it the "absolute block system."

I think I can safely say that by my correspondence with the Government upon the subject they acknowledge me the inventor of the "absolute block system" of signalling on railways, made compulsory by Act of Parliament, August 30th, 1889, by which all railway passengers are compelled by Act of Parliament to travel under my scientific guidance.

I therefore challenge Mr. F. W. Cooke, in the sum of £5 (five pounds) to prove that I am not the inventor of the present system of railway signalling known as the "absolute block system," made compulsory by Act of Parliament, August 30th, 1889, the challenge money to be given to some charitable institute.



a, Electric contact breaker wires; *b*, Treadles *c*, Rails.

I enclose a sketch of the Automatic Absolute Block System, so that any of your various readers will understand the system and see that it is impossible to have a collision if faithfully carried out.

Christopher J. Little, M.S.A.

17, Groombridge Road,
South Hackney, N.E.

[We do not think any useful purpose will be served by a continuation of this discussion.—Eds. Elec. Rev.]

Paper Telephone Cables.

I have been much interested in the article in the current issue of your paper on "Paper Telephone Cables," as in the latter part of 1891 and early part of 1892 I made a very large number of tests on some paper telephone cables which were being made for the New York Telephone Company, for their underground lines running through the City.

These cables consisted of No. 18, No. 19, and No. 20 B. and S. wires, insulated with paper, wound in a loose spiral; each pair of wires being twisted together, and various pairs being strained up in the usual manner, the whole being held together by a cotton braid.

The cables were dried for 24 hours at a temperature of not less than 220° F., including several hours under vacuum. The cables were passed directly from the drying pans and covered with lead, the ends being saturated for about a foot or 18 inches of their length with paraffin to exclude moisture.

The diameter of a single wire covered with paper was ·125 inch. With these cables we had no difficulty in obtaining a capacity of between ·080 and ·085 microfarad per mile.

Most of the cables were made up in lengths of about 300 feet; this being about the average distance between the conduit man-holes.

At the same time we made several experiments on single wires with various methods of insulation.

We used a single No. 18 B. & S. wire, insulated with paper to a diameter of ·125 inch, dried for ·24 hours at a temperature of 220° F., including 4 hours under vacuum, all wires covered with lead; one sample of each insulation having the lead pressed on very close to the insulation, and in the other case the lead being pressed on loosely. The lengths of cable being about 200 feet.

Nature of treatment.	Close lead.		Loose lead.	
	Capacity per mile mfds.	Insulation per mile megs.	Capacity per mile mfds.	Insulation per mile megs.
Dry, twine and two papers ...	...	...	·105	v.h.
„ ordinary single paper ...	·184	v.h.	·109	v.h.
Paraffined	·239	v.h.	·117	v.h.
Vaseline	·326	683	·16	1,710
T. & C. compound	·205	v.h.	·129	v.h.
Double-boiled linseed oil ...	1 00	53	·514	26
Paper saturated before covering with paraffin, ⅔rds, and vaseline, ⅓rd	·328	1,060	·151	1,600
Kerosene	...	...	·117	v.h.
Ozokerite	...	...	·110	v.h.

(v.h. = over 485,000 megohms.)

Temperature of water in tank in which cables were submerged, 44½° F. The insulation was measured with an E.M.F. of 500 volts. Capacity with E.M.F., 100 volts.

F

The following are results on some cables which we made about the same time, the diameter of the insulated wires being ·125 inch unless otherwise stated :—

Cable consisting of:	Insulation.	Capacity per mile, mfds.
7 No. 18 B. & S. ...	Jute and T. & C. compound ...	·181
7 pair No. 18 B. & S.	Dry hard paper	·117
7 No. 18 B. & S. ...	Cotton and T. & C. compound	·246
20 No. 19 „ ...	Paper, resin and vaseline ...	·221
7 No. 16 „ ...	Jute and T. & C. compound ...	·218
19/16 B. & S. ...	„ „ „ ...	·226
25 No. 20 B. & S. ...	Paper and T. & C. compound; diameter ·110 inch. ...	·180
19 pair No. 18 B. & S.	Dry hard paper	·1135
52 „ „ „	Dry loose paper	·0906
26 „ 19 „	Hard paper and T. & C. compound; diameter ·10 inch	·178
51 „ „ „	Loose paper	·0836
7 „ 18 „	Dry loose paper	·0793
7 „ „ „	Paraffined loose paper ...	·107
50 „ „ „	„ „ „ ...	·115

Trusting that this information may be of interest to some of your readers.

Arthur Churchill.

We have been asked by those gentlemen for whom we are acting as experts in connection with the patent Leno cable, to point out certain inaccuracies in the article entitled "Paper Cables used in Telephony."

Your writer remarks that the great difference in the speaking properties of rubber and paper cables is due to the much lower specific inductive capacity of the paper. Some improvement is due to this, but the great diminution of solid dielectric in paper cables is the chief gain. It is in reducing by 25 per cent. this quantity of solid material without reducing the interval between the wires and lead that Leno secures a 15 per cent. improvement of capacity.

The statement that "the capacity of paper is very little above that of air which is taken as unity" must not pass as accurate. The specific capacity of the paper used for telephone purposes is about 1·8, and is 40 per cent. nearer the figure given by the writer for rubber than to unity the figure for air. Hence, again, the use of substituting air for paper in the meshes of a cellular substance. Cellulose materials have a further advantage in the absence of resinous size or gum which is slow to take up electric strain which figures so importantly in rubber compositions.

It is stated by "E. J. J." that the minimum capacity of a rubber cable is ·29 microfarad, a remark which is of as little use without the overall diameter of the cable as the next, which says that a mile of paper-insulated wire should not exceed ·085 microfarad where the overall dimensions are given *wrong*. No paper cable having 612 wires 20 gauge and an outside diameter of $2\frac{3}{4}$ inches (inside diameter 2·48 inches) ever gave an average capacity of ·08 microfarad. We have (assisted by Mr. Braby) as the result of innumerable calculations and experiments plotted the curve connecting capacity per mile and sectional area of copper per unit of air space in the lead tube. Such capacity results as "E. J. J." names are too good to be true.

Again, a paper cable having the capacity and diameter stated, will be found to have an insulation resistance of many thousand megohms per mile. It is possible to adjust the insulation of a paper cable at the expense of dampness in the paper from 1 megohm to 200,000 megohms per mile, but although this high figure has been obtained on half mile lengths of 408 wire cable without scorching the paper and without any particular manufacturing expenses, it is undesirable telephonically.

On the other hand, a well-distributed low insulation is sometimes obtained at the expense of capacity, but as the specific inductive capacity of water for alternating currents of telephone frequency is about 80 (air = 1), the moisture which lowers the insulation raises the capacity enormously. The difficulty of distinguishing between a distributed and local leakage is so great that for a given Manilla paper the test relative capacity to insulation has not yet been determined with any accuracy.

Passing to a further point in the same article, it is stated that the paired spiral method of insulation of cables is the one which gives the greatest amount of air space. The simple test of abstracting the core from a given length of cable and weighing the dry paper has, in a given case, shown the amount of paper (and copper) to be greater, and hence the air space less than in the previous methods. Should an individual test be considered insufficient, we would point out that these cables have in no way proved their supremacy (by giving the same capacity as other systems in a smaller lead tube), and that although the manufacture is cheap and rapid, it is doubtful whether the wires are distributed to the best advantage in the tube space; in fact, the members of a pair have been considered to be too close together for the best results. Making solid the ends of a telephone cable with *lead* for a distance of 6 inches is a very rare proceeding, and a retrogression from the use of a mixture of wax and pitch, which is quite satisfactory, and cheaper.

We have touched upon many statements, the accuracy of which does not affect the future of the patents which we have alluded to, but we trust to have shown that the writer has overlooked many important facts, among which are those which form the basis of an important improvement.

O'Gorman & Cozens-Hardy.

66, Victoria Street,
Westminster, S.W.
April 12th, 1899.

The Ambleside Tenders.

In response to the appeal of "A Contractor" in your last issue, I have examined the payment clauses in the Ambleside specification, and have done my best to unravel them, but I fear your correspondent will not obtain the "clear and definite statement" he desires except from a Judge in Chancery.

The specification defines three contracts:—No. 1, for gas engines; No. 2, for generators and battery; No. 3, for conductors.

The terms of payment for the gas engines are fairly simple. 50 per cent. of the contract sum will be paid on delivery; but to ensure this payment, the contractor should give notice in advance and receive cash as the goods cross the threshold. 40 per cent. will be paid on the engineers' certificate of completion, and the balance of 10 per cent. at the expiration of the six months' term of maintenance.

If any defect should arise during the said six months "from a known cause other than insufficiency of material, workmanship or design," then the liability of the contractor will cease.

Consequently the liability of the contractor under this head is not serious.

Contract No. 2.—The conditions of payment under this contract are much more complicated than the above.

I think the contractor may fairly expect to obtain 50 per cent. of the contract price on delivery, provided he tenders the whole of the apparatus at one time in exchange for cash.

The specification says that the 50 per cent. on delivery shall be paid on the certificate of the engineers, but as only one certificate is provided for it is obvious that the engineers will not sign it until the plant is complete. I suggest, therefore, that the contractor should tender the goods and demand payment, leaving the Council to settle the legal difficulty with the engineers.

With regard to the remaining 50 per cent., I consider it is beyond the wit of man to say in what sums or when the contractor would obtain it. At the end of the five years' maintenance he would have a clear claim to the balance, but if the battery should break down, say, from insufficient charging, even within the first three months his liability for maintenance would cease and the balance would become due forthwith, this, of course, is all in favour of the contractor.

Contract No. 3.—This contract for conductors does not include any terms of payment, therefore the contractor will have no claims either under the contract or under common law until after the completion of the three years' period of maintenance, when his obligations under the contract will have been fulfilled and he will be entitled to his contract price.

John S. Raworth.

March 11th, 1899.

The letter from "Contractor" in your columns last week has evidently been written without careful consideration as to the payment clause.

The plant will be paid for six months after being put to work according to specification, and 76 per cent. of the amount allowed for the battery will also be paid. This includes a sum for five years' maintenance, so that in reality, the contractor gets 76 per cent. of the value for this work before he will have had to spend a penny on upkeep.

This is how I have taken the specification to read.

One who is Anxious to Secure the Order.

Balancing of Armatures.

In reference to Mr. Hill's article on this, he conveys the impression that when an armature is run in bearings free to move, the heavy side will fly outwards, and be marked by a piece of chalk held near. Now I believe I am right in saying that when the speed is high, the armature will tend to rotate round its centre of gravity, so that the light side will fly out and be marked with the chalk.

For this reason the Laval steam turbine wheel is mounted on a long slender shaft. Did the heavy side tend to fly out, this method of mounting would be unworkable. The balancing of high speed armatures is very difficult. An armature which will run perfectly at certain speeds will vibrate most seriously at other speeds. Hence it may happen that an armature would be all right at its speed, if it could be run up. These remarks apply especially to armatures run at, say, 3,000 or 4,000 revolutions per minute.

C. Turnbull.

April 10th, 1899.

A Word to Municipal Works Committees.

Your columns have recently contained some observations on the subject of tendering for public works which are of interest to most contractors; will you allow me to call attention to a small detail in the preparation of the elaborate "Forms of tender," employed by local authorities, which if attended to would scarcely add anything to the cost of some of these "technico-legal editions de luxe," and certainly would prove a real convenience to contracting firms, that is, that the actual sheet filled in by the person tendering and containing the vital points of the contract should be printed in copying ink. At present a manufacturer preserves a press facsimile of the most trifling details of his correspondence, but generally has to rely upon a hand copy for the important terms of these large contracts because he is bound to use the printed forms supplied.

Should you consider this of sufficient interest to warrant insertion, permit me to thank you for so doing.

J. W. Beauchamp.

Three-phase Currents from Direct Current Generators.

I should be glad if any of your readers could give me some information on the following:—

A direct current generator of 100 kw. capacity operates a motor load at a pressure of 500 volts. By suitably tapping the armature windings would it be possible to obtain the *whole* of the output in three-phase form? The three-phase load would be inductive, and consequently the drop would be great. The writer believes American practice is to use *carbon* brushes for collecting the three-phase currents at the slip rings. Is there any electrical advantage in this?

A Continental electrician recently stated that such a machine could not be made to operate satisfactorily, both as a direct current and three-phase generator. Is this so?

J.

A Suggestion.

If, as I gather, it is impossible to syntonise the two main circuits of the Marconi telegraph, would it not answer the same purpose if we could tune the sending key and the receiver? So that although the coherer responded to all waves, the action of the inker would be selective and would only record those signals sent out by the particular key with which it is in tune?

E. Bennett Viles.

THE ELECTRIC LIGHTING OF THE CITY.

A specially convened meeting of the Court of Common Council was held on Monday at the Guildhall for the purpose of discussing the question of electric lighting within the City boundaries. The Lord Mayor (Sir John Voce Moore) presided.

The report of the Streets Committee was then submitted by Mr. Algar. It contained five recommendations. In a preamble the Committee said that relative to the electric lighting inquiry by the Board of Trade, submitting a request by Sir Courtenay Boyle, K.C.B., to be furnished with the views of the Corporation and evidence of the engineer with reference to the three applications of electric lighting companies for provisional orders to supply electricity within the City, they recommended that evidence be tendered on the resumption of the said inquiry by the Corporation engineer, in accordance with the request of Sir Courtenay Boyle, and by the electrical engineer; that if, notwithstanding the terms of the agreement with the City of London Electric Lighting Company, the Board of Trade see fit to exercise the power conferred upon them by Section I. of the Electric Lighting Act, 1888, this Court is of opinion that the Board of Trade should not grant more than one provisional order, for the reason that a multiplication of the systems of supply would be prejudicial to the interests of the Corporation when the time comes for them to take over the responsibilities of electric undertakers; that this Court is of opinion that the Board of Trade should not dispense with the consent of the Corporation, unless in the case of an applicant who is prepared to accept the insertion in the provisional order of such terms and conditions as will secure the immediate and future interests of the private consumers and the public; that should the Board of Trade decide to grant competition in the City, it should be subject to the Corporation having the right to purchase the whole of the undertaking, whether within or without the City, on terms to be previously agreed upon by the Corporation, and set out in the provisional order; and that provision should be made in any provisional order to guard against the possibility of combination between two competing undertakers to the disadvantage of the electric light consumers and of the City of London.

Upon the presentation of the report an opinion of Mr. Danckwerts on the question was pressed for and read by the Town Clerk. The effect of the learned counsel's opinion, which was of considerable length, was that the contract of the Corporation with the Electric Lighting Company was now null and void from the fact that several members of the Court were interested in the company.

Mr. Algar then moved that the report be referred back to the Committee in order that the opinion of another counsel may be obtained.

Mr. Morton reminded the Court that counsel had already expressed the opinion that the contract was, to use his own words, "as dead as mutton," and he (the speaker) hoped there would be no attempt either to whitewash the Electric Lighting Company, or, indeed, anybody else.

Mr. Turner seconded the motion to refer the matter back for further discussion, and the Court adjourned for half-an-hour.

On resuming, Alderman Sir Henry M. Knight, acting *pro. tem.* for the Lord Mayor, presided.

Mr. Algar read two letters which had been addressed to the Town Clerk. The first was from the Smithfield Market Electric Supply Company, and asked the Court to receive the petition which had been signed by several thousand citizens in favour of allowing them to compete. The other letter was from the Charing Cross Electric Supply, stating that they had secured the refusal of a site in the City and another outside the City for the generation of electricity. Consequently, they were in a position to supply all the City's needs.

Mr. Wallace said they should determine that they would have no more companies in the City, and if there were to be competition, the Corporation should be the competitor. He moved that the proposal to appoint the electrical engineer to give evidence be deleted.

Mr. Lile, who seconded, said they must do all in their power to prevent any other company from entering the City.

Mr. Turner said the electrical engineer was an intelligent officer who had done good work for the Corporation. They were all liable to mistakes and should recognise that fact.

Mr. Cloudesley trusted that the question would be judged on its merits, and not regarded in any sense as concerning any officer.

Mr. Brooke-Hitching pointed out that they were in the peculiar position of being prevented from being represented by one of their own officers.

Several members defended the action of the Corporation officers, and Mr. Algar said there could be no doubt that Mr. Voysey made a mistake, which he had already admitted.

On a division the proposal was adopted.

Mr. Edwards then moved that professional and scientific evidence should be given, as recommended in the report of the Streets Committee. Mr. Tranter seconded.

Mr. Brooke-Hitching said if the motion were persisted in, he should have to move an amendment.

Mr. Moojen said from the decision of the Court it appeared that expert evidence as to the bad quality of the light could not be given by their electrical engineer. He thought that the ratepayers, who were the real sufferers, should be allowed to give evidence.

The Lord Mayor's *locum tenens* stated that a large body of consumers had already given evidence.

Eventually it was agreed *nem. con.*, on the motion of Mr. Brooke-Hitching, "That in view of counsel's opinion, Sir Courtenay Boyle be informed that the Corporation prefers to withhold further evidence at present, thus leaving itself free to consider the question of providing its own supply."

The motion, upon being agreed to, was received with applause.

PARLIAMENTARY COMMITTEES.

County of London and Brush Provincial Electric Lighting Company.

The Select Committee inquiring into the above Bill resumed its sitting on Tuesday last, after the Easter recess, Sir W. Coddington presiding.

On the opening of the Committee, Mr. Pember, Q.C., said that since the Committee adjourned they had received a letter from the Board of Trade which came upon them like a bolt from the blue. The letter was dated April 4th, and was as follows:—"With reference to the application made by you on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, for the above-mentioned order, I am directed by the Board of Trade to state that they are not satisfied that the consent of the local authority should be dispensed with in regard to any of the districts included within the proposed areas of supply, and they don't therefore propose to proceed with the application." He thought the Board of Trade were somewhat to blame, because they might have written the letter months ago, as the applications were made in October. They had asked the Board of Trade to hold a local inquiry, the same as they were now holding in regard to the City, to see whether the local consent should be dispensed with, but they had refused. Under the circumstances they would be compelled to amend their application. The promoters had asked for provisional orders to enable them to supply with electricity the districts of Fulham, Battersea, Bermondsey, Rotherhithe, Lewisham, Lee, Greenwich, Eltham, Poplar, Bethnal Green, Hackney and Stoke Newington. The Bill would now be amended and the promoters would confine their application to ask for powers to lay mains through Shoreditch, Bethnal Green, Islington, Whitechapel, Battersea and Lambeth.

Mr. Worsley Taylor, for the London County Council, said the action of the Board of Trade showed the exceeding inconvenience of the course which had been adopted by the company. They had promoted a Bill only one-half of which had been disclosed to the Committee, and under the charged circumstances he should feel it necessary to consult with his clients as to what form his opposition should take.

Mr. Pember: It simply means that we ask for less extended powers than we did before.

Mr. Worsley Taylor: More than half of the Bill has gone now.

The Chairman said he thought the action of the Board of Trade in putting off their refusal until April 4th seemed to be rather discourteous, but the Committee had no jurisdiction over that authority. The letter, however, did make such a great change in the Bill that he did not think it would be right to ask Mr. Worsley Taylor to go on immediately.

Mr. Rickards (Chelsea Water Company), Mr. Wedderburn, Q.C., (for the Greenwich and Blackheath Electric Lighting Company), Mr. Vesey Knox (Lee District Board), and Mr. Lewis Coward (on behalf of the Fulham Vestry), asked the Committee for the costs to which their respective clients had been put to in appearing, now that they had been struck out of the Bill.

The Chairman said the Committee would reserve their decision on the point.

Mr. Worsley Taylor said that he would withdraw from the Committee under the altered circumstances of the case, the County Council reserving its right to oppose the Bill hereafter if necessary. He would submit to the Committee to consider whether it was right that the Bill should be gone on with, seeing that the promoters had emasculated it so much.

Mr. Statham then addressed the Committee on behalf of the Lambeth Vestry, and asked the Committee to pause before they gave a commercial company the powers they sought over local bodies.

Mr. John Smith, the Lambeth Vestry clerk, in reply to Mr. Statham, said that already there were three bodies supplying electric light in the parish. They had no hostility to the promoters as such, but they objected to their having compulsory powers of breaking up their streets. The local body was the best judge as to which streets should and which should not be broken up.

Cross-examined by Mr. Pember, the Witness said he objected to the power given in the Bill by which the Board of Trade should have the right to adjudicate between the company and the Vestry in respect to the breaking up of the roads. That would result in making the Board of Trade practically the local authority.

Mr. Tagg, clerk to the Camberwell Vestry, gave evidence in opposition to the Bill, on the ground that it might injuriously affect the Vestry in regard to the special purchase clause they obtained from the company in 1895.

Mr. Talbot then addressed the Committee on behalf of the Camberwell Vestry, after which counsel on behalf of the Shoreditch Vestry addressed the Committee in opposition to the Bill.

The Committee then adjourned.

The Committee reassembled on Wednesday, when the chairman, Sir W. Coddington, said that the Committee did not think it necessary to hear any more evidence in opposition to the Bill, as they had come to the conclusion that they could not pass the preamble. With reference to the applications made the previous day for costs, the Committee had considered the matter and had decided not to allow costs. He then formally announced that the preamble had not been proved.

An Improved Nernst Lamp.—It is reported that Herr Rasch, an engineer, of Nurembourg, has devised an improved form of Nernst electrolytical lamp which does not require a high temperature.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week ending Mar. 17th, 1898.

Port.	Value.
Adelaide	£10
Albany	43
Alexandria. Telep. mat.	49
Amsterdam	300
Bangkok	89
Bombay	50
,, Teleg. cable	670
Boulogne	24
Buenos Ayres	81
,, Teleg. mat.	310
Cape Town	820
Colombo	78
Delagoa Bay. Teleg mat.	3,710
Demerara	58
Durban	714
Flushing	14
Fremantle	30
Gibraltar	121
Gothenburg	171
Hong Kong	10
Key West. Teleg. cable	1,400
Launceston	11
Lisbon	425
Madras	107
Malaga	334
Malta	16
Melbourne	59
New York. Teleg. mat.	525
Ostend	65
Port Elizabeth	51
Stockholm. Teleg. cable	60
Sydney	186
Wellington	445
Total	£11,036

Week ending Mar 14th, 1899.

Port.	Value.
Alexandria	£200
Amsterdam	133
Antwerp. Electric fuses	261
Bombay	280
,, Teleg. mat.	152
Boulogne	112
Buenos Ayres	6
Calcutta	1,920
Cape Town	137
Colombo	102
Dunkirk	250
Durban	98
East London	26
Flushing	41
Genoa	500
Hamburg	590
Hong Kong	14
Melbourne. Teleg. mat.	210
Montreal	10
Nagasaki	2,151
Ostend	70
Perth	56
Port Chalmers	28
Port Elizabeth	323
,, Telephones	1,194
Rio Janeiro. Teleg mat.	190
Rotterdam. Teleg. mat.	116
Singapore	25
Sydney	158
Trieste	150
,, Teleg. mat.	28
Wellington	26
Yokohama	73
Total	£9,980

Foreign Goods Transhipped :—

Rouen.	Railway elec. appts.	£230

Electrical Wares Exported.

Week ending Mar. 22nd, 1898.

Port.	Value.
Alexandria. Teleph mat.	£912
Amsterdam	160
Antwerp. Elec. fuses	151
Barcelona. Tele. wire	46
Boulogne	22
Brisbane	138
Buenos Ayres	65
Cadiz	20
Calcutta	1,158
Cape Town	1,285
Colombo	92
Copenhagen	12
Delagoa Bay	27
Durban	145
Flushing	31
Fremantle	7,201
Genoa	55
Gothenburg	341
Hong Kong	180
Jaffa	20
Liban	243
Madras. Teleg. cable	8,200
Ostend	53
Port Elizabeth	1,616
Reval	1,200
St. John's, N.B.	172
St. Petersburg	20
Singapore	16
,, Teleg. mat.	66,280
Sydney	82
Wellington	75
Total	£89,318

Week ending Mar. 21st, 1899.

Port.	Value.
Alexandria	£150
,, Teleph. stores	23
Amsterdam	200
Barcelona	31
Berbice	13
Boca. Teleg. mat.	106
Bombay	186
,, Teleg. mat.	180
Boulogne	159
Brisbane	18
,, Teleg. mat.	209
Buenos Ayres	3,358
,, Teleg. mat.	539
,, Teleph. mat.	76
Calcutta	258
Cape Town	328
Christiania	63
Colombo	65
Delagoa Bay	95
Durban	343
,, Teleg. mat.	103
Ghent	25
Gothenburg	72
Hamburg	200
La Plata	20
,, Teleg. mat.	88
Limon. Teleg. mat.	86
Melbourne	47
Odessa. Teleg. mat.	20
Ostend	85
Port Elizabeth	391
Rangoon. Teleph. mat.	16
Santa Cruz	35
Shanghai	229
Singapore	99
,, Teleph. mat.	21
Sydney	554
Tientsin. Teleg. mat.	104
Wellington	179
,, Teleg. mat.	190
Total	£8,914

Foreign Goods Transhipped :—

Barbadoes.	Teleph, mat.	£18	Gothenburg.	Teleph. apparatus	£2

Allam v. Reilly.—This was an action to recover damages, brought in the Westminster County Court on Wednesday by Mr. Edwin Percival Allam for breach of contract and £5 odd for work done and materials supplied. Plaintiff was an electrical engineer of long standing. Defendant was a publican, and agreed to pay him £20 to charge and trim his three arc lamps for a year. He broke the contract. The charges for work, &c., were fair and reasonable. The contract would have nothing to do with the mechanism of the lamps. The lamps were only constructed to burn for six or seven hours. Mr. Reilly stopped plaintiff's man from seeing to the lamps, stating he had got someone to do the work cheaper. For the defence Mr. Geo. Sampson, manager of the Electric Light Insurance Company, Mr. Wm. Lowrie, of the same company, and other witnesses, gave evidence showing that plaintiff's man did the changing and trimming badly. The lamps continually went out while plaintiff was attending to them. The rods were never properly cleaned by plaintiff's man, nor did he attend to the fuses. His Honour found for the plaintiff for £5 with costs.

Announcements.—House's Cement and Anticrustator Company, Limited, manufacturers and merchants, Marlboro' Works, 34, Vauxhall Road, Liverpool, advise us of change of trading name of the company to House & Co., Limited.

Mr. H. Calderbank has opened a showroom for electrical fittings, &c., at 78, King Street, Manchester.

Barnet Automatic Telephone Meter.—This meter, to which we made some reference in these columns some weeks ago, is designed to register cumulatively the time during which the telephone is in circuit for conversation, *i.e.*, when the switch lever is raised by the removal of receivers (to record 1,000 hours). The meter is started by raising the switch lever, and stopped by the lowering of same. It is also automatically wound up when the switch lever is thrown out of circuit by replacing the receiver, the action being the pulling down or depression of the switch lever. The vertical play or movement of the lever in the "Ericcson" telephone being only half an inch (½"), and in some other makes less, but this is found sufficient to automatically wind up the meter, so that it will go for at least 15 minutes or as much longer according to arrangement.

Books Received.—"Spon's Architects' and Builders' Price Book, 1889," by W. Young. Twenty-sixth edition. London: E. & F. N. Spon.

"The Motor Car Manual," by R. Moffat Ford. Motor Car Company, Long Acre, W.C. 2s. 6d.

Catalogues, Lists, &c.—The Simplex Steel Conduit Company, Limited, Birmingham, send us a copy of their new price list. It is got up in attractive style, and contains a quantity of useful information relating to the conduit system of wiring, some wire tables and perforated requisition or order forms for conduit supplies. The list includes the latest novelties and improvements introduced by the company, including new forms of inspection pieces, X and Y shapes; right angle cross pieces (4-way and 5-way); detachable brass pieces to facilitate drawing in; Simplex pendant fittings, stiff and flexible, both in vertical and horizontal types; Simplex lampholder fittings mounted on ebonite cheeks to maintain insulation resistance; Simplex switch and ceiling rose boxes, also fitted with ebonite plate to fill requirements for high voltage. They are also bringing out water-tight arc lamp brackets and water-tight runs for incandescent lighting for exterior lighting, and an ordinary wall bracket for workshop, hospital and corridor use. They inform us that while the patterns shown in their lists are those in more general demand, they are prepared to modify these to suit the requirements of their customers.

Messrs. Laing, Wharton & Down, Limited, issue a neat little pamphlet giving particulars and illustrations of the Vril electric launches and describing the equipments.

From the British Fire Prevention Committee we have received a pamphlet giving descriptive notes and pictures of its testing station on the Regent's Canal.

Messrs. Stanley, Davies & Pollard, of Hyde, send us lists of their 5 and 50 E.H.P. non-condensing steam dynamos, the engines being of the "Sentinel" type, and 15 kw. "Standard" continuous current dynamo.

Committed for Trial.—Five men have been committed for trial by the Greenwich Stipendiary on a charge of stealing a quantity of electric cable, the property of the Crystal Palace Electric Supply Company.

Dinners.—On 5th inst. the staff and employés of Messrs. Donnison, Barber & Co., of Manchester, were entertained at the Exchange Hotel to a sumptuous dinner to welcome the new manager (Mr. Batty), and to say farewell to the outgoing (Mr. Linsell). The latter gentleman was the recipient of a handsome gold albert, presented by the staff, and of a gold keyless English lever watch from Mr. Barber. About 50 sat down, and the evening closed with a most enjoyable "smoker."

On Saturday evening last the employés of Messrs. Drake and Gorham's Manchester Branch were entertained to a dinner at the King's Arms Hotel, Manchester, by their manager, Mr. W. Cotsworth. This was followed by a smoking concert, during which the presentation of a handsome secretaire was made to Mr. Cotsworth, as a mark of esteem and respect, and to celebrate the occasion of his forthcoming marriage.

Electricity for Mines Drainage.—At the monthly meeting of the South Staffordshire Mines Drainage Commissioners last week, the question of utilising electricity for the further unwatering of the mines in the Tipton district was again referred to. Mr. R. Williams said the scheme for draining the surface by electrical means had been held up to be the saviour of the district—that they would no longer be troubled with water in the mines. With respect to the proposals of the Midland Electrical Corporation for Power Distribution, if the scheme contemplated by the commission could be carried out the water would be prevented from getting into the mines from the surface, and it would be one of the greatest blessings they had ever experienced. The commissioners had reduced the "come" of water from 36,000,000 gallons to 9,000,000 gallons every 24 hours, but unless the electrical scheme could be carried out the 9,000,000 gallons would practically be a fixed quantity, to deal with which they would have to keep the whole of their pumping engines in operation. The chairman (Mr. J. B. Cochrane) remarked that before launching out in the larger electrical scheme it was proposed to put down a small electric plant at one of the pumping stations as an experiment. In connection with this matter it may be mentioned that although the Electric Power Distribution Company are meeting with opposition from several of the local authorities within the district over which they desire to operate, the opposition in no way interferes at present with the plans of the Mines Drainage Commissioners. As is well known the Tipton mines' drainage area is not co-terminous with the boundaries of the parish of that name, but includes areas within the jurisdiction of a number of district councils. These, however, are not opposing the power distribution scheme, the promoters of which have, therefore, a wide area and a large customer to cater for. Meanwhile Dudley is making arrangements for the starting of a municipal electric works for the supply of power and light within the borough, and if the Drainage Commissioners desire to use electricity in that district, they will have every opportunity.

Liquidation Notice.—The Electrical Time Recording Company meeting at 31, Bedford Row, London, on April 5th, decided to wind up voluntarily, Mr. A. B. Clifton being appointed liquidator.

A New Engine.—Messrs. Willans & Robinson have now under test the first engine they have made of the 3 V size, indicating 1,000 horse-power at most economical load, 1,200 H.P. as maximum continuous load, and 1,500 H.P. as emergency load. It is intended for dynamo driving for traction work, and is one of a set of eight ordered for an English municipal traction scheme. At the same time there is on the steaming bed an engine of 3 R size intended to indicate from 500 to 600 H.P., one of the two ordered for the City and South London Railway Company.

New Works.—A Liverpool paper says that an electrical syndicate are contemplating the erection of large works in close proximity to the Ship Canal at Cadishead.

Radford v. Tasker.—At the Coventry County Court on Tuesday, before his Honour Judge Ingham, Edward R. Radford, of Leicester, claimed from Messrs. W. Tasker & Sons, Limited, electrical engineers, £50, for commission on orders obtained by him whilst engaged at the firm's Coventry depôt. After hearing and consultation plaintiff agreed to accept £37 10s., with costs on that amount. His Honour gave judgment accordingly.

Removals.—Mr. G. L. Addenbrooke notifies that as the Parliamentary and other work in connection with the undertaking of the Midland Electric Corporation is now nearly complete, he has closed his Wolverhampton office, and all communications should now be addressed to him at 53, Victoria Street, S.W.

Theft.—At the Salford Police Court on 4th inst., James Bailey was sent to prison for two months with hard labour for stealing a quantity of electric fittings and other articles, the property of the General Electric Company, Limited, valued at £11 10s.

Trade Notice.—Messrs. Chas. R. Compston & Son, Lancaster, have announced the sale of the electrical stock-in-trade of Mr. N. H. Edmondson, electrical engineer, Morecambe.

ELECTRIC LIGHTING NOTES.

Arbroath.—At a recent meeting of the Gas Corporation it was stated that the Board of Trade had informed the deputation by which it was interviewed that it proposed to delete the transfer clause from the provisional order. The Corporation is desirous of retaining it, and will apply accordingly.

Bangor.—The installation of the electric light has been initiated at Bangor by its introduction into the slate works at Port Penrhyn. The installation has been carried out by Messrs. Lindsay, Browning & Co., Limited.

Barton (Manchester).—The Board of Guardians have decided to apply to the Local Government Board for sanction to borrow £3,355 for lighting the new Union Infirmary at Patricroft. The light is to be generated on the grounds.

Bath.—A discussion arose last week at the meeting of the Electric Lighting Committee regarding the financial position of the electricity undertaking. Mr. Metzger's report showed that there was an overdraft on revenue account of £2,318, and on capital account of £2,938. The capital overdraft was not of any importance, because the treasurer has power to raise £4,000 more. The book debts ending March were about £1,500. The treasurer said that the profits would, so far as he could see, about pay off the interest, but the repayments of capital would have to be found elsewhere. There was also a brief debate *re* the humming of the arc lamps, which was said to be quite a nuisance. It was resolved to write to Mr. Hammond requesting him to take such steps as are necessary immediately to remove either the cause of the noise, or the lamps themselves.

Bethnal Green.—The Board of Trade has approved of the draft provisional order applied for by the Vestry.

Bolton.—The Electricity Committee have appointed two assistant electrical engineers out of a large number of applicants, the successful gentlemen being Mr. B. S. Hornby, assistant electrical engineer to the Bradford Corporation, and Mr. A. T. Gordon Smith, assistant electrical engineer to the Taunton Corporation.

Bootle.—It is expected that the electric lighting works will be completed by April 20th.

Bournemouth.—The Board of Trade has signified that it will be prepared to grant a provisional order to the Council for public purposes only. The Board is being requested to grant the

order as originally drawn, and, if necessary, to hold a local inquiry. A report advising as to the scheme and its cost has been submitted by Messrs. Lacey, Clirehugh & Sillar.

Canterbury.—At the last meeting of the Town Council it was resolved to inform the residents in Northgate, one of the principal thoroughfares in the city, and leading from the centre of the city to the electric light station, that the Council cannot now erect arc lamps in that street as desired, since it would entail considerable alteration with regard to the cable and in the plans, but they would place at intervals 50-C.P. incandescent lamps. It was decided to obtain 75 additional incandescent 50-C.P. lamps, and six dozen opal glasses, and the same number of bent glasses for the public lamps for stock. The engineer was directed to purchase 74 lamps and two brackets for erection on the routes of extended mains, at an estimated cost, including separate switch wires, switch pillar, &c., of £1,150.

Carlisle.—On Tuesday the Council agreed to extend the electric lighting cable to various parts of the city.

Chelmsford.—The town clerk, acting on the advice of the Special Committee, has appointed Mr. Robert Hammond to advise as to the value of the works of the Chelmsford Electric Lighting Company, with a view to the purchase of the undertaking.

Chesterfield.—The letter received by the Council from Messrs. Davies & Saunders, and printed in our last issue, is to be discussed at the next meeting of the Council.

Colchester.—The Town Council have decided to accept the offer of Messrs. Siemens to light and maintain in the streets four large 100-C.P. lamps by incandescent light during the same number of hours as now lighted and at the same price per annum as now paid for gas, and to bear the cost of the fittings in the first instance.

Cork.—A local correspondent says that electric lighting is making great progress. The latest important addition is an installation at St. Augustine's Church, just completed by Messrs. Handley & Shanks.

Coventry.—A party of members of the Coventry Technical Institute Engineering Society paid a visit on Tuesday evening to the Corporation electricity works, where they were received and conducted over the premises by the manager, Mr. G. S. Ram.

Darlington.—The Corporation are now inviting tenders for the erection of electricity works buildings.

Dawlish.—A representative from Messrs. Taylor and Field, electrical engineers, will attend before the Council on the 19th inst. and give particulars *re* electric lighting.

Devonport.—From the 35 applications sent in for the post of resident electrical engineer at £300 per annum, Messrs. C. H. Furness and E. G. Orkell were selected to appear before the Electric Lighting Committee.

We understand that the Committee has now selected Mr. Furness. His appointment was to be discussed by the Council yesterday, and if passed Mr. Furness will enter upon his duties on June 1st, and in the meantime will devote his leisure to studying the problem of a site for the central station, the solution of which is said to be one of the greatest troubles of the Electric Lighting Committee. Prof. Kennedy, who has hitherto been the professional adviser of the Committee, is to be retained as consulting engineer.

At a meeting of the Town Council yesterday Alderman Stanbury was to move that the Council proceed to the lighting of all the main roads in the outer wards with electricity forthwith.

Douglas.—The Town Council has decided to adopt electric lighting for the borough at an estimated cost of £12,000. The Committee has been asked to formulate a scheme on lines laid down by Prof. Fleming, and submit details to the Council. The question was discussed of approaching the Tramway and Electric Power Company to do the work, but the motion received little support.

Dudley.—The Corporation have decided to spend £7,500 in providing an electric lighting station, and it is to be erected under the superintendence of Mr. Reginald Wilson, by whom the Council have been guided. The matter has been somewhat hurried, in consequence of the unexpected development of the arrangement between the Electric Traction Company and the Corporation.

Dundee.—The electrical engineer has reported the addition of 10 new consumers and 876 lamps during March. The number of units generated was 68,503, and the coal used 606 tons odd, or 9·28 lbs. per unit generated. Coal is 9s. 11d. per ton.

Durham.—With reference to the application of the authority for a provisional electric lighting order, the Board of Trade has refused to give the Council power to sell absolutely, or even to lease the proposed powers. The Council is communicating with the Board of Trade with the object of getting them to reconsider their decision.

Edinburgh.—The Electric Light Committee has passed the following resolution:—"That the Committee cannot recommend the Council to depart from the statutory provisions of the electric lighting order at the present stage, and beg to recommend in the meantime that no special or separate fund for renewals should be formed apart from the reserve fund already established for that and other purposes, conform to the resolution of Council, February 28th, 1897." In another resolution:—"The Committee further recommend that the reserve fund should be made up to its maximum as soon as may be convenient."

The Electric Light Committee has agreed to obtain estimates for copper and cable to connect the new station at M'Donald Road with the rest of the system throughout the city, at a probable cost of £28,000. Estimates were considered for the erection of four new boilers for Dewar Place station, and these were remitted to the engineer to consider and report. It was stated that there had been 3,682 8-C.P. lamps applied for since last meeting.

Fulham.—The Vestry will make application to the London County Council for their sanction to borrow the sum of £100,000, the repayment to spread over a period of 42 years, for the purpose of carrying out the electric lighting works. 46 applications were received for the post of clerk of works.

Grimsby.—On 6th inst. a Local Government Board inquiry was held into the Council's application to borrow £43,500 for electric lighting purposes.

Halesowen.—The Council has adopted a report by the General Purposes Committee, in which it is stated that a letter had been received stating that the Board of Trade had written to the clerk's agents that they had determined not to allow any electric lighting orders, including transfer clauses, this session. The clerk had written to his agents that it was very important that the Council should have the means of dealing with the electric lighting question in the best way for their district, and asking them to press the Board of Trade as strongly as possible to allow the transfer clause.

Hampstead.—The Vestry has agreed to lay mains for the supply of current to private consumers in Adelaide Road (Primrose Hill Road to Eton Road), St. Cuthbert's Road, and Woodchurch Road.

Hebden Bridge.—An installation has just been put in for the lighting of Salem Wesleyan Chapel by Mr. R. S. Blackburn, comprising a dynamo for supplying 200 16-C.P. lights and a set of accumulators.

Hereford.—The city surveyor has issued a description of the proposed electric lighting installation. It will be a three-wire low pressure system, consumers to be supplied at 220 volts. There will be two 30-feet × 7 feet 6 inches Lancashire boilers, with Meldrum's forced draught, two Belliss compound two-crank engines of 150 B.H.P. each, and two 100-kw. Silvertown single horse-shoe under type dynamos, with drum bar armature, each giving an output of 440 to 500 volts and 200 amperes at 450 revolutions per minute; also a battery of 270 chloride R type cells, having a capacity of 660 ampere-hours when discharged in nine hours, and the various steam plant accessories, balancing transformers, &c. This is for private lighting only at present.

A Local Government Board inquiry was held last Friday with reference to the loan of £20,000 for the cost of the installation.

Hull.—A short circuit across the outer mains of the Old-Town three-wire system led to a failure of supply on the morning of the 1st inst. This caused considerable inconvenience to the *Hull News* and *Eastern Morning News*, whose printing presses are worked by electric motors. In consequence those publications were delayed several hours beyond publishing time. The previous day there was a short on the mains in Park Street.

Ingleton.—The Electric Lighting Company hopes to be able to light the town by the end of the summer. The sources of water supply have been inspected by representatives of Messrs. Gilbert Gilkes & Co., of Kendal. A large proportion of the required capital has been subscribed locally.

Liverpool.—At last week's City Council meeting the minutes of the Electric Power and Lighting Committee, which were approved, included a recommendation that the contract with Callender's Cable and Construction Company, Limited, for the supply, laying, and maintenance of underground electric mains be extended for a further period of two years from May 6th, 1899; and a recommendation that, as from April 1st, 1899, the following prices be charged for the supply of electrical energy:—For lighting, 4d. per unit; for power up to 3,000 units per quarter, 2d. per unit, and for each unit over 3,000 units 1d. per unit; for Corporation lighting of streets, 2d. per unit; for Corporation lighting of buildings, &c., 3d. per unit.

Lowestoft.—On 7th inst. a Local Government Board inquiry was held into the application of the Corporation for leave to borrow £30,000 for electric lighting. Mr. Hawtayne explained the scheme.

Luton.—The Town Council has had another long debate on the electric light question. The strongest opposition has been offered to the municipal project, but the stage has been reached of securing the approval of the Board of Trade for the scheme. The committee recommend that tenders be invited for the execution and completion of the works, and after a discussion of details the question was postponed for a month.

Middleton.—At the meeting of the Town Council last week Alderman Walker, on the minutes of the Gas and Electric Light Committee, said they hoped soon to come to some definite arrangement with the Manchester Corporation with regard to the supply of electricity for the tramway scheme, which would then be proceeded with.

Motherwell.—The Police Commissioners have approved plans of the proposed electric lighting station, and Prof. Kennedy was instructed to push on the work as rapidly as possible.

Manchester.—On the morning of the 10th inst. there was a failure in the Corporation electric supply in the neighbourhood of Market Street. A local paper says there was something wrong with the mains.

Musselburgh.—The Town Council last week signed an agreement with the Drake & Gorham Electric Syndicate, whereby the company pledged themselves to supply electric light to the burgh at 6d. per unit, and for public lighting at 4d. per unit.

Newington.—After a brief discussion, in the course of which such questions as trade union wages and "hole-and-corner" appointments were introduced, the Vestry referred back the proposal to empower the Electric Lighting Committee to appoint the requisite working staff for the electricity station for £1,120 a year.

Newport.—The Borough Council has been served with a writ at the suit of Mr. Stephen Sellon, applying for an injunction to restrain the Corporation from working their electric lighting machinery so as to cause annoyance and inconvenience to him in his business. Unless a settlement can be arrived at, the action will be defended, and a committee will consult with the town clerk in the conduct of the defence. In a report from the consulting electrical engineer, it is stated that the cost of shunting operations in the delivery of coal would be reduced by the use of an electric capstan, to cost about £200. Further particulars are to be brought up on the point.

Perth.—Mr. Hawtayne's report upon the offers made by various companies for the transfer of the Council's provisional order has been considered, and the Council has decided to keep the matter in its own hands and carry out the work. Mr. Hawtayne has been instructed accordingly.

Provisional Orders.—In the House of Commons on Tuesday leave was given Mr. Ritchie to bring in a Bill, and it was read a first time, to confirm certain provisional orders relating to Glossop, Ilkeston, Cromer, and other places.

Rothesay.—The Council on Monday agreed to proceed with the electric lighting of the harbour and front of the town, and to accept the offer of Messrs. Lowdon Brothers, for the sum of £2,501 19s. 2d., the work to be completed in 13 weeks.

St. Annes.—The electrical engineer to the Council has presented his estimate for the installation of electricity in St. Annes, and it is stated to be more than twice the amount the Council proposed originally to outlay. The Council had the matter before it again on 5th inst.

Salisbury.—There is some feeling locally in favour of the municipal purchase of the undertaking of the local electric light company.

Shrewsbury.—Since the electric light undertaking was taken over by the Corporation the Lighting Committee have carefully considered what steps should be taken to put the works and mains into a thoroughly efficient state, so as to meet the increased demand from private consumers, as well as to proceed with the lighting of the streets and public buildings. After conferring with Mr. Johnston, the electrical engineer, the Committee state they are of opinion that four arc lamps should as soon as possible be installed in some of the main streets, viz, two on Bride Hill, one on Mardol Head, and one in Mardol. The estimated cost of laying down the necessary cable and providing and fixing the lamps is £159. The desirability of the electric light being used in such public buildings as the Mayor's Court, police station, baths, free library, and waterworks is, the Committee state, evident, and to supply the several buildings named it will be necessary to extend the cables, each of which would be available for connections to be made for the use of private consumers. The cost of this extension is estimated at £250, and the Committee recommend the work to be put in hand as early as possible. The Committee state it will also be necessary to considerably extend the works and provide a reserve both of boiler power and generating plant, and they estimate the necessary expenditure upon plant and extensions at £4,130. At a meeting of the Town Council on Monday sanction was given to these extensions.

South Shields.—At the last Council meeting it was resolved to reduce the prices of current from 7d. and 3d. to 7d. and 2d. per unit respectively; also to extend the mains, putting down four sub-stations, high tension feeders, and low tension distributors along 10,000 yards of street frontage. Application is to be made to the Local Government Board for leave to borrow £21,150 to carry out the extensions as advised by the engineer. The following tenders were accepted:—Messrs. Ferranti, switchboard, £1,047 2s.; British Insulated Wire Company, cables, £3,606 18s. 10d.; F. Lumsden, buildings, £2,296. Sanction was received from the Local Government Board for the recent application for borrowing £19,564.

Southampton.—The Electric Lighting and Tramway Joint Committee having considered the report of Mr. Manville as to new works, recommend the Council to apply to the Local Government Board for power to borrow £17,159 for the purpose.

Southport.—Mr. C. D. Taite, the Corporation electrical engineer, has estimated that £55,000 will be required for the necessary extensions to the electricity works during the next two years. The principal items in this outlay are rendered necessary by the provision of electric tramway plant and buildings. The undertaking is continually increasing, and whereas the number of consumers in the year ending March, 1895, was only 72, the number for the year ending March, 1899, is 520, whilst there are now 35,487 8-C.P. electric lamps connected, compared with 5,340 four years ago. The Electricity Committee have resolved to apply to the Local Government Board for power to borrow £55,000.

Stretford.—The Council have decided to apply to the Board of Trade for the renewal for a period of two years of the 1897 provisional order. The question of electric lighting and haulage, which was on the agenda paper at the last meeting, and a resolution to the effect that a consulting engineer should be appointed at a salary not exceeding £300 a year, to advise the committee with a view to the preparation of a definite scheme, was dropped, owing to the absence of Mr. Wardale, who had given a notice of motion.

Sunderland.—At the County Council on Wednesday, the chairman of the Electric Lighting Committee stated that the revenue for the past half-year was £6,883; the gross profits £1,657, and after paying the sinking fund, &c., there was a net profit on the working of £320—a result which the Council thought eminently satisfactory.

Tunbridge Wells.—The minutes of the Lighting Committee adopted by the Council last week contained the following:—The engineer presented a report with respect to the extensions necessary for the provision of the machinery required for an additional 10,000 8-C.P. lamps, together with a plan of the proposed enlargement of the central station, and it was resolved that the plan be referred to the Works Committee for their consideration, and that the electrical engineer be instructed to ascertain at what price Messrs. Ferranti would supply another alternator, similar to the one recently supplied by them. The electrical engineer presented a report, suggesting that the Corporation should take steps for the enlargement of their area of supply under the electric lighting order, and the Committee recommended that the further consideration of the matter be deferred. The engineer reported that the National Electric Free Wiring Company had commenced work in the borough, and a copy of the agreement with the consumer under the arrangement with the National Electric Free Wiring Company was submitted to the Committee.

Ventnor.—A letter received from Edmundsons' Electricity Corporation suggesting that they be instructed to improve the street lighting by introducing additional arc lamps for certain thoroughfares in lieu of gas lamps has been referred to the Lighting Committee.

Wallasey.—A Local Government Board inquiry was to be held on Wednesday respecting the application of the District Council to borrow £10,000 for electric lighting purposes.

Walsall.—The Electric Lighting Committee has reported to the Town Council that with a view to encourage the use of large quantities of current, they have resolved to allow additional discounts. Where the total yearly consumption reaches 10,000, but not 15,000 units, 10 per cent.; where the total yearly consumption reaches or exceeds 15,000 units, 12½ per cent. This is in addition to the present discount of 2½ per cent. for payment within one month. The Walsall Theatres Company, Limited, have just decided to put the electric light in St. George's Hall, Walsall.

West Derby.—On 7th inst. an electric lighting installation was inaugurated at the Mill Road Infirmary. It has been put in by the Guardians at a cost of about £7,000. The installation consists of 1,400 16-C P 110-volt lamps. There are two boilers of the dry-back return tube type, each 7 feet 6 inches in diameter by 13 feet long, and having two flues. Steam pressure, 125 lbs. per square inch. The boilers are manufactured by Messrs. Fawcett, Preston & Co., Liverpool. The generating plant consists of three quick-revolution steam engines by Mirrlees, Watson & Yaryan, each coupled to a shunt-wound Wilson Hartnell dynamo, capable of giving 300 amperes at 110 volts. For supplying current at night and during the time the engines are not at work a battery of accumulators of 900 ampere-hours capacity is provided, arrangements being made either to charge the batteries through a booster from off the lighting circuit or direct from any one dynamo. The wiring throughout the building is run in insulated steel conduits on the distribution board system. The contractors were:—Engine room plant, Mr. Scott Anderson; batteries, the Chloride Electrical Company; wiring, Messrs. Woodward & Craig, Glasgow. The electrical plant is to the designs and specifications of Mr. Thomas L. Miller, of Liverpool.

Weybridge.—In view of the Council's opposition to the proposed provisional order of the Walton and Weybridge Electric Works Company, Limited, the Board of Trade writes that it is not intended to proceed with the application for the order.

Whitechapel.—At a recent meeting of the District Board of Works, Mr. Wright, the electrical engineer, intimated that the work of laying mains was about to commence, and he also suggested that Mr. Tapper, of Brighton, be appointed resident electrical engineer. It was stated that the streets of the district would be lighted by electricity in September. Mr. Wright's communication was referred to the Electric Light Committee, with power to act.

Whitefield.—Householders are to be circularised by the District Council asking if they are prepared to use the electric light in the event of it being provided.

Winchester.—The Town Council at their monthly meeting on April 6th agreed, on the recommendation of Committees, to accept the tender of Messrs. E. H. Gudgeon & Co., of Lewisham, to fit the municipal buildings and clock tower at the Guildhall with electric light for the sum of £98 17s. 9d.; and the tender of the same firm for lighting the public reading room, library, and school of art for £115 10s.

The electric light has just been installed in the Winchester Congregational Church, and a proposal for introducing it into St. Thomas's Church is being considered.

Windsor.—At the Easter Vestry Mr. Churchwarden Harmer stated that, after striking an average over ten years, the saving effected by lighting Holy Trinity Church and its clock by electricity instead of gas, was £13 per year.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barnsley.—The Tramway Committee recommend that the Town Council vigorously oppose the application now being made to Parliament by the British Electric Traction Company.

Blackpool to Poulton-le-Fylde.—A scheme to extend a system of electric railways from Blackpool to Poulton-le-Fylde and on to Carleton to join the Blackpool and Fleetwood system is in course of development.

Cardiff.—The Council has appointed the chairman of the Tramway Committee and the borough engineer to visit towns, and prepare a report regarding the generation of power for tramway traction.

Chatham.—A local correspondent says that there is very little doubt that in a short time electric trams will be running through the districts of Chatham and its popular dockyard suburbs of New Brompton and Luton. The Light Railways Commissioners have issued an order (subject to the confirmation of the Board of Trade) for the construction of a system of light railways for Chatham, and it is proposed that these shall take the form of electric cars. Chatham and New Brompton are to be connected by one long main line; another will run from the Military Road, Chatham, by way of the Brook, on to Luton. From here a branch line will run up Chatham Hill and join the terminus at New Brompton. A very important line, and one that will be an immense advantage to the dockyard employés, will be that which will run from Chatham and New Brompton to the upper and lower dockyard gates, both to the Chatham and Gillingham ends of the yard. Another line will run to the new pier at Gillingham, and will carry passengers to the important works of the Royal Engineers' School of Military Engineering, the Royal Engineers' Submarine Mining and Torpedo Works, and the Brennan Torpedo Factory. When the lines are completed every facility will be provided for Chatham, but unfortunately Rochester does not join in the scheme.

Coatbridge and Airdrie.—Letters on this subject were read at Airdrie Town Council from Mr. Kennedy, Parliamentary agent of the General Traction Company, again offering to apply for a Bill to construct a tramway in the burghs, provided they got the support and consent of both Corporations; from the British Electric Traction Company, proposing to take steps next session to promote a provisional order under the Tramways Act; also a letter from the town clerk of Coatbridge, stating that his Council had resolved to co-operate with Airdrie Council as to the prospects of a scheme to form a trust for constructing a tramway in the two burghs. A letter was also read from Messrs. Paterson, Bell & Co., electrical engineers, Bath Street, Glasgow, asking the Council to consider a scheme under the Tramway Act, which the British Schuckert Company, of London, would submit if agreeable. Provost Connor thought that the scheme proposed by Coatbridge Town Council was the only one before them, and if they studied the interests of the ratepayers, they would do all in their power to support it. He thought that no one would be bold enough to go in for anything else, and consequently asked that the Council consent to meet the Coatbridge Corporation as requested. This was unanimously agreed to.

Dublin.—One of the overhead trolley wires in Westmorland Street broke down on Saturday night, causing a stoppage in the car service for 20 minutes.

Eastbourne.—In addition to the proposals of the British Electric Traction Company for the construction of tramways here, inquiries have been received from another source as to the possibility of the Corporation consenting to an application for power to construct tramways. The town clerk has replied that the Corporation is applying for powers, and will oppose any company application. The borough engineer has been instructed to prepare plans for tramways or light railways for certain routes.

Electric Tramcar Accident.—A Reuter's telegram from Nancy, dated 6th inst., says that an electric tramcar was passing along the Rue St. Jean there when the brake broke and the vehicle dashed down the street at full speed, colliding at the bottom of the incline with another tram. Fourteen persons were slightly injured.

Glasgow.—The Tramways Committee have just approved of a report by Mr. John Young as to the conversion of six additional car routes for electric traction. The Committee are asking the Corporation for instructions to take steps to proceed with the work. Mr. Young's estimate is as follows:—Paisley Road and Parkhead route, £35,000; Paisley Road and Possilpark route, £11,400; Pollokshields and Garscube Cross route, £2,800; Maryhill and Mount Florida route, £54,050; Langside and Seamore Street route, £4,900; Paisley Road and Oatlands route, £2,150. Total, £110,300, less cost of renewal of lines in ordinary course, £55,000 = £55,300. These estimates include permanent way, alterations and renewals, bonding, ducts for feeders, and overhead construction. Depôts for cars, &c., at Kinning Park, Whitevale and Maryhill, would cost £13,814.

In respect of the appointment of Mr. Parshall as consulting engineer in connection with the conversion of the tramway system, Mr. Paterson asked the convener at the last meeting of the Corporation whether the appointment would preclude the estimating for work by firms all over the world. He said it was well known that the person proposed to be appointed was committed to a firm in America—at least, had a predilection in favour of that firm. Mr. Paton said he was sorry to hear such a statement regarding a professional man. It was evident that Mr. Parshall was meant. There was not a shadow of foundation for any statement which indicated that Mr. Parshall was committed either to any firm in America or in this country. It was one of the stipulations that, if Mr. Parshall were appointed, all his specifications were to be on the plan that the work was to be open to anybody who chose to offer.

Greenock.—The Special Tramways Committee of the Police Board have decided to invite Mr. Young, manager of the Glasgow tramways, to visit the town and inspect the tramway system and report as to its condition, with special reference to municipalisation or leasing.

Hyde.—At the last meeting of the Council Alderman Oldham, in submitting the minutes of the Tramway Committee, said they had met the representatives of the Oldham, Ashton, and Hyde Electric Tramway Company as to matters in dispute, and he thought they would be arranged satisfactorily without the threatened recourse to law. The company had now paid to the borough treasurer the £550 they promised towards Ring o' Bells Corner. Mr. Barron complained that the company were behaving shabbily in not completing the tramways. The work should have been finished last August, but they had applied to the Board of Trade from time to time for extensions, and they were now proposing to apply for another extension until August. The Corporation ought to let the company know that the people of Hyde had had quite enough of this delay. Mr. Alderman Oldham said the delay was caused through the electric light apparatus at Ashton not being ready. They had, however, given the company as much latitude as was reasonable, and it would be for the committee to consider the advisability of opposing any further extension of time.

Manchester.—At a meeting of the Tramways Committee on Tuesday the chief business transacted arose on a report from Mr. Wordingham, the electrical engineer, on the subject of the generation of electrical power for the propulsion of the tramcars of the city. Up to within a week or so ago it was generally accepted that the Electricity Committee would supply the power necessary, and large sums of money have been borrowed by the latter committee, part of which was to be expended in making the arrangements necessary for equipping the Corporation tramways with motive force. Mr. Parshall's recent report to the Glasgow Corporation, is stated by a local paper to have somewhat disturbed this view of things. Mr. Wordingham's report deals with the whole question of electrical installation in the city. He shows that the main lines of the system advocated for Glasgow by Mr. Parshall are already in working operation here. With respect to the advice that Glasgow should keep its generating stations distinct, Mr. Wordingham says that what may be suitable for Glasgow would not correspond with the needs of Manchester. In Glasgow the electrical system is quite unsuitable for combined lighting and traction. In Manchester, on the other hand, the whole electrical equipment of the city has been instituted with a direct anticipation that at some future time it would be required in the propulsion of our tramways. Mr. Wordingham thinks that Manchester with a combined generating station for the two purposes of tram-haulage and electric lighting will be able to beat Glasgow in cost of production if the latter adopt the system of separate production. He also considers that with a combined station there will be great economies in staff and supervision, that the losses from idle plant will be smaller, and that the expenses of laying mains and maintaining sub-stations will be less than with separate generating stations. In Manchester the type of machine used is absolutely identical for the two purposes, so that it will not be necessary to provide the double staff of attendants spoken of by Mr. Parshall in his report. These were the principal arguments on both sides which the Tramways Committee had to discuss. After a prolonged consideration of the several points at issue, a sub-committee was appointed to confer with the Electricity Committee and to obtain such expert advice and assistance as may be deemed necessary.

Newcastle.—Mr. Laws, the city engineer, has reported to the Tramways Committee of the Newcastle Corporation as to whether in the streets in the centre of the city some system other than overhead traction is practicable to be worked in conjunction with the overhead system in other streets. After saying very strong things against the overhead wire, and making remarks about conduit, surface contact, and accumulator systems, Mr. Laws sums up thus:—"Unless expert opinion condemns the conduit as unworkable in this climate, it should be adopted as against the trolley, certainly in the major part of the town. If the Council comes to that opinion, the 'Simplex,' or some modification of it, is the most promising, and failing that, 'The Love.' But, again, unless expert opinion condemns the 'Accumulator' as worked at Copenhagen, and it proved to be financially impossible, that is preferable to either conduit or trolley."

Worcester.—The City Council has agreed by 17 votes to 13 to authorise the Streets Committee to obtain expert advice as to the probable cost of taking over the tramway undertaking, and as to the probable cost of adopting electric traction.

(*Continued on page* 602.)

THE ELECTRIC LIGHTING OF LEITH.

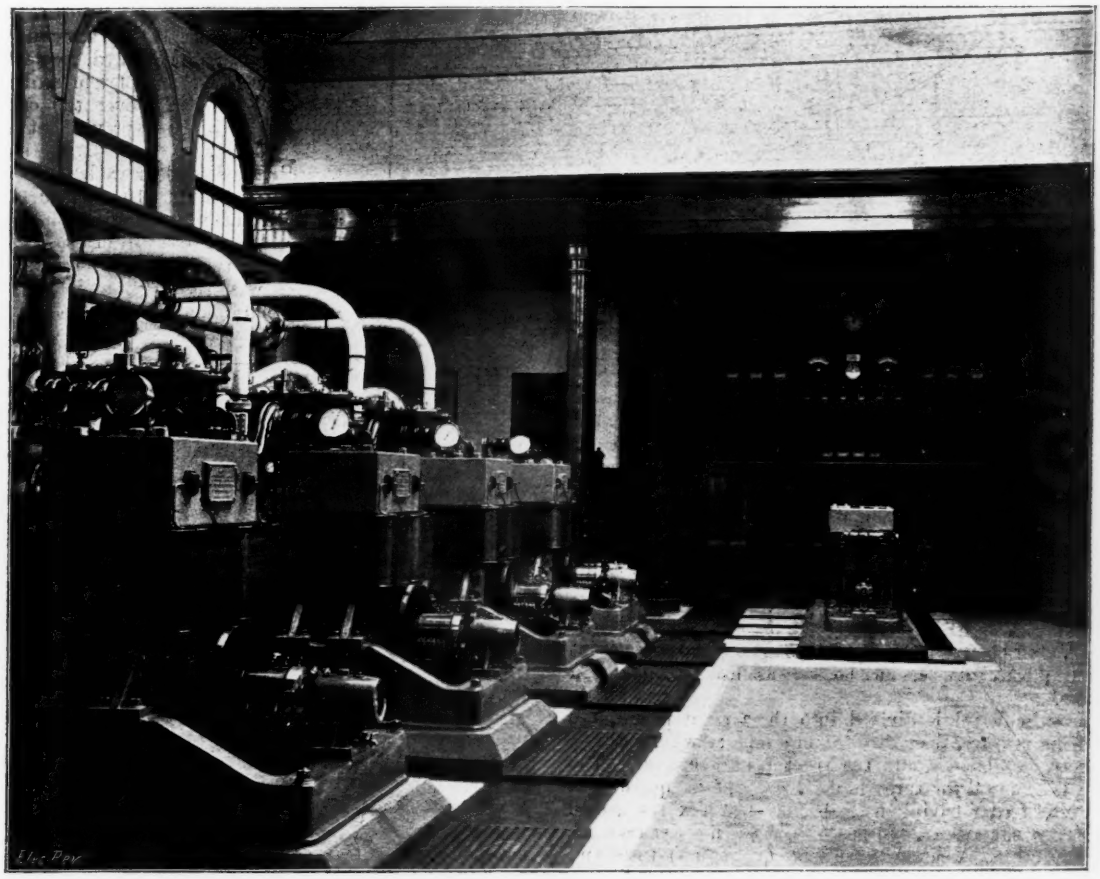
A point of particular interest connected with the construction of the Leith Corporation electric lighting station is the short time occupied in erecting the buildings, constructing and setting up the plant, and the getting of the station to work.

The tenders for plant were asked for in December, 1897, and the contract placed in January, 1898. Possession of the ground for the engine house was not obtained till May 28th, 1898, when the building operations were at once commenced. The street lighting was switched on by Provost Bennett on December 23rd, 1898, and shortly afterwards the public supply was commenced. No consulting engineer was employed, the whole of the scheme being arranged by and carried out under the supervision of Mr. W. A. Bryson, the burgh electrical engineer, to whom great credit is due for the manner in which he has overcome the many difficulties accompanying the carrying out of the work in the limited time. The Electricity Committee and their active convener, Bailie Manclark, spared no efforts to this end.

The following general description will give an idea of the capabilities of the installation :—

The boilers, which were supplied by Messrs. Sinclair, of Leith, are of Lancashire type, 30 feet × 8 feet, and suitable for a working pressure of 160 lbs. to the square inch, are fitted with Hopkinson's high steam and low water and also dead weight safety valves, and Meldrum's forced draught is fitted to the furnaces, enabling a low class of fuel to be employed with economy. The economiser, of Green's make with 480 tubes, has the scrapers driven by an electro-motor of the enclosed type. The shaft is exceedingly well built and of ample proportions, being 150 feet high and 10 feet in diameter, with the usual fire-brick lining.

Two feed pumps were supplied and erected by Messrs. Carruthers, of Glasgow, who also supplied and erected the feed pipes, tank, &c., together with a very ingenious valve switchboard for regulation of the various feeds and suctions. The steam dynamos, balancers, boosters, switchboard, accumulators, steam and exhaust pipes, were supplied and erected by the India-Rubber, Gutta-Percha, and Telegraph Works Company, of Silvertown.

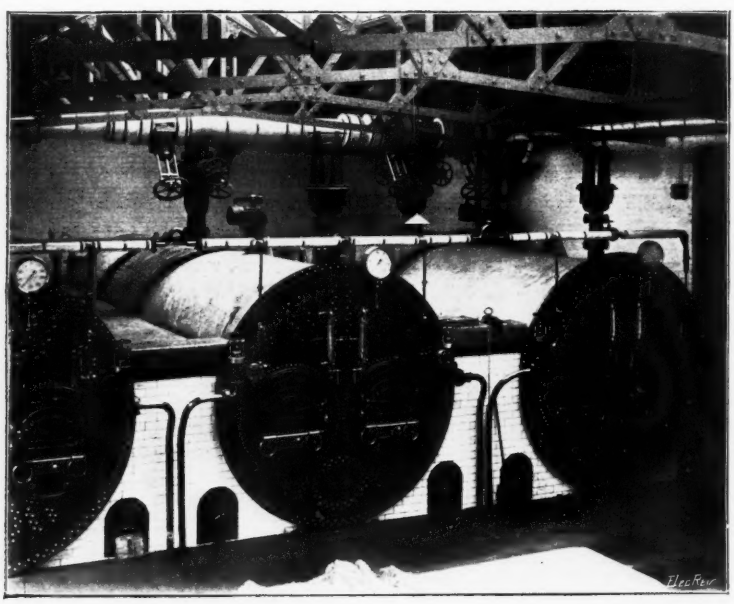


General View of Power House.

The generating plant consists of five Belliss-Silvertown steam dynamos, one having an output of 60 kw. at 500 revolutions, and four of 92 kw. each at 450 revolutions, the working potential being 460 volts. The engines are of Messrs. Belliss's latest type, and are fitted with the usual forced lubrication. The dynamos have bar drum-wound armatures with shunt-wound fields, and are fitted with continuous ring lubrication to end bearings. The engines are supplied with steam by a completely duplicated system of steam piping, with all necessary valves, for isolating any particular boiler or engine.

The steam mains are of lap-welded steel 10 inches in diameter, drained by means of four Royles patent expansion traps. The branch steam pipes are of copper throughout,

those to the engines being connected to Y-pieces on the engine separators. The exhausts are carried in a trench



Boiler House.

of ample size, and are of copper from engine exhausts to below the floor plates, where the exhaust valves are placed; the main exhaust is of cast-iron 18 inches in diameter, and is carried to the top of the shaft.

Provision is made in the main exhaust for the attachment of calorifier pipes, so that the exhaust steam can be used for heating the new swimming bath adjacent to the station. These baths also form the feed tank for boilers, an arrangement obviously beneficial to the baths, and giving a large reserve of feed water to the electric light station. The whole of the steam pipes, flanges, &c., are covered with magnesia sectional covering, and the exhaust with skye diatomite.

The balancer, which is capable of transferring 150 amperes from one side of the system to the other, is combined with, and drives two boosters for accumulator charge and discharge, each booster being capable of giving 90 amperes at 90 volts; both balancers and boosters are fitted with carbon brushes.

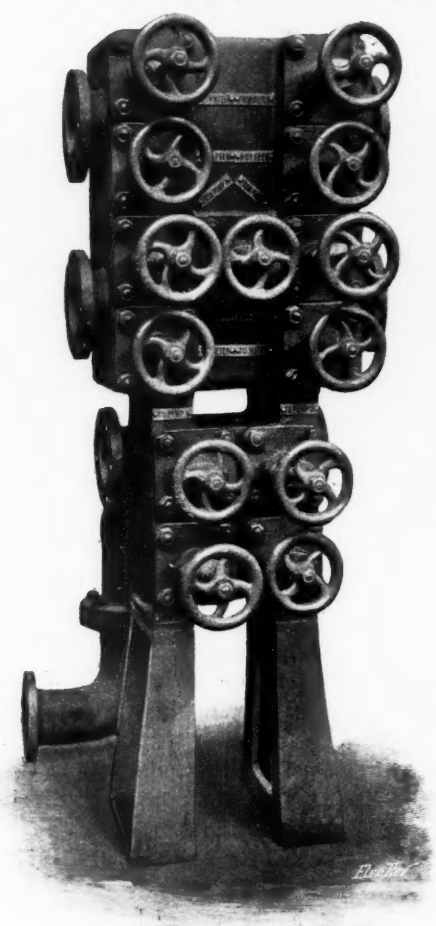
The switchboard is divided into three main panels, the left being positive, the centre for the middle wire, battery, balancer, and booster, and the right being negative. The board is arranged for three feeders, each of ·5 square inch area, each feeder having both + and − duplex fuses, with mica screens, ammeter, and bus bars. The five dynamos are connected through automatic cut-outs (minimum) fuses and ammeters to their respective bars. The centre panel contains the voltmeters, with double pole switches, the booster bus bars, balancer starting switches, interlocked battery regulating switches and booster switches, booster field switches and middle wire, booster and balancer ammeters. The dynamo, booster bar, and battery voltmeters are of Lord Kelvin's multicellular pattern, and the feeder voltmeters of the Weston illuminated dial type. A recording ammeter is placed between the middle wire and earth. The shunt regulating resistances are placed in a very commodious chamber underneath the switchboard gallery, the switches being carried on a shelf running along the top of the gallery rail in front of the switchboard.

The switchboard frame is of wrought-iron, the slates are enamelled on both sides, and are held to the frame by brass bolts. Around the switchboard is a very handsome screen, designed by Mr. Simpson, the burgh architect and designer of the buildings.

The accumulators are of the E.P.S. type, 256 in number, having a capacity of 750 ampere-hours at 100 amperes discharge. They are contained in a spacious accumulator room, situated immediately over the switchboard, and exceptionally well ventilated. The connections between the accumulators, dynamos, &c., and switchboard are insulated with vulcanised India-rubber and lead covered.

The engine room contains ample space for an addition of 1,500 H.P., and the arrangement of steam and exhaust pipes allows for such addition with the minimum of expense. A travelling crane capable of lifting 8 tons is provided. Ample accommodation for the engineer and his staff is provided in the station.

The contract for the underground mains, arc lamps, and posts was given to the British Insulated Wire Company, and includes three feeders, each of ·5 square inch section, and one subfeeder of ·3 square inch section. The distribution cables are triple concentric, ·15 × ·15 × ·1 square inch section. The pilot cables are triple 7/20 conductors, and the arc lamp leads 7/15. The mains are all lead covered and served, but not armoured, protection being given by means of tempered steel plates laid directly over the cables. Fused feeder boxes are provided at feeding and distributing points. The street lighting consists of 74 arc lamps of the Crompton-Pochin 10-ampere type arranged nine in series. That the lighting has every chance of success is proved by the fact that before the station was running application for over 5,000 lights had been received, so



Feed Valves in Combination Valve Chest.

that the town of Leith has every reason to congratulate itself on having joined in the march of progress, and we

wish every success to the new venture. It is also only fitting that we should add our congratulations to the convener and to the burgh electrical engineer, in his double capacity of consulting and resident engineer, the success attained being also a strong testimonial to the abilities and industry of Mr. Best, the Silvertown Company's engineer-in-charge, and the other contractors engaged on these works.

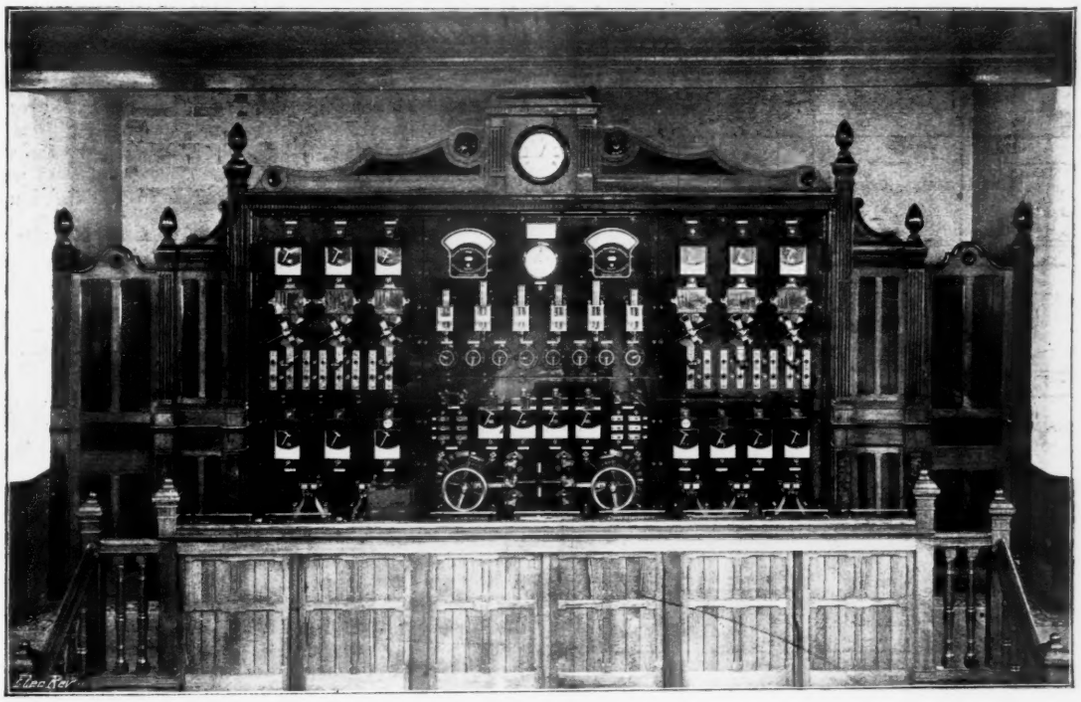
ELECTRIC PIPING.

(*Concluded from page* 539.)

Having established the fact that tubing in some form or other is necessary to secure safe wiring, Mr. Bathurst is not long in arriving at the truism that we must employ iron to resist iron, but he thinks that plain iron piping is only the intermediate stage, on the way to insulating conduit, for the reasons which we have already quoted. But there is one point which we should like Mr. Bathurst to answer satisfactorily; in the course of wiring many buildings with an iron piping system, it is often necessary to cross girders or stanchions, or to dodge gas and water pipes. In these cases the use of "normal" bends, such as are listed, is *quite impossible*, and this is where gas piping has such an advantage to offer, as it can be made red hot at a forge, and "set" to the exact curve required. Those who have used some of the patented systems of piping have experienced this difficulty, and have expressed the opinion that these systems are only suitable for wiring the usual run of houses. But, perhaps, there may be some satisfactory reply to this allegation which it would be of interest to hear. Of course the many arguments and points made by Mr. Bathurst against plain iron piping—such as ridges in the interior due to the welding, and all the risks resulting from frayed wires, burrs, insufficient fusing, condensation, &c.—may be more or less overcome by the use of weldless steel tubes, or other systems of tubes in vogue, and a properly designed and carried out scheme, allowing for a well sub-divided fuse system, efficient bushing of all fuse, and switchboards and patrasses well soaked in paraffin wax—so as to reduce all leakage to a minimum. It would be interesting to hear what the advocates of other conduit systems have to say on this point, and no doubt there are many consulting engineers and architects who have had different conduit systems under their supervision, and their opinions would be valuable.

Of course, the great aim of everyone nowadays is to bring all things within the reach of the masses, and the only way to do this is through the medium of the pocket. No trade has been more strangled by legislative enactments and petty bye-laws than the electric wiring business, with the result that until recently the electric light has been almost entirely at the disposal of the rich only, and if progress has been made for enabling the great middle class to share its advantages, it is only due to the fact that (1) the cost of supply has been reduced, and (2) free and municipal wiring has been introduced, by which the consumer is enabled to pay off the cost of wiring his house in instalments, although he has to pay more in the end. But wiring *per se* has not been cheapened, and any scheme which aims at this end is worthy of consideration, as it will, of course, if adopted, benefit the community at large.

It is, of course, within the knowledge of everybody conversant with electrical matters, that one means towards cheapening the cost of wiring is to "earth" the so-called "return" wire in an installation, thus reducing the number of insulated wires by about one half, although the first cost cannot actually be reduced for various reasons found in making a practical "earthed outer" system. Several of such systems have been in existence for a long time, but their use has been exclusively confined to private plants owing to the taboo which the supply companies have put on any system of "earthing." However, all these so-called "concentric" systems of wiring, of which those owned by Messrs. Mavor & Coulson, Mr. J. D. F. Andrews, and Messrs. Sharp & Piper are the best known, consist of solid cables in which the outer is made up around, and protects the inner; and the only case we know of in which a tube is actually used as the return circuit is a system of insulated wires inside Muntz metal tubes recently devised by Messrs. Handcock & Dykes, and installed in several buildings where the supply has been private. The question of "earthing" one pole of installations supplied from public mains is a very large one, and no doubt the companies have had excellent reasons in the past for refusing to sanction this, the chief ones being electrolytic troubles due to earth

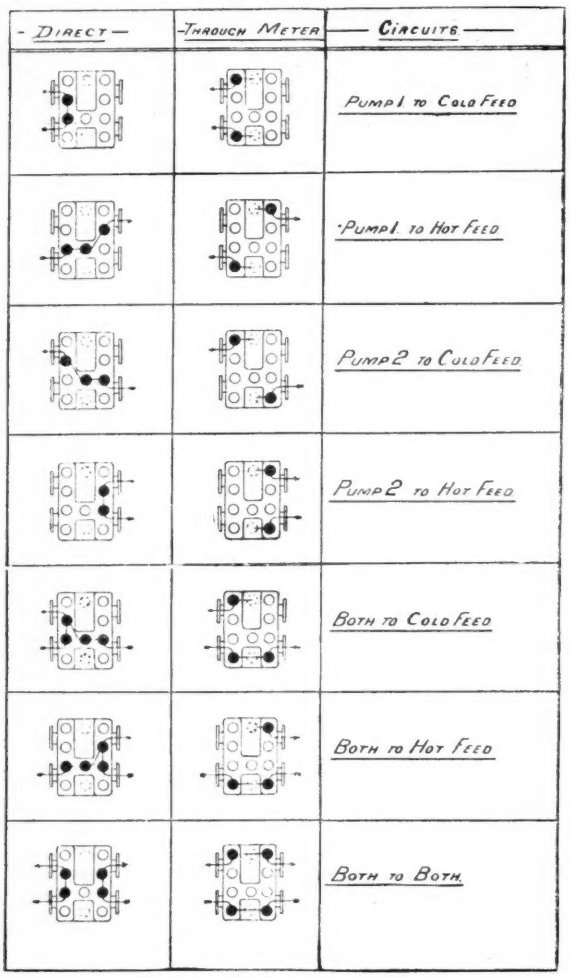


The Electric Lighting of Leith.—Switchboard.

currents between various earthed points on one main at different potentials, and the dangers arising should any point on the opposite main become accidentally earthed. These objections cannot, however, be put forward in the case of alternating current low tension systems worked off transformers, although should the primary circuit of a transformer inside a house become "earthed" certain dangerous conditions might arise.

There is no doubt, however, that if it can be proved that an "earthed" conduit or tube system can be installed more cheaply than wires in wood casings, the whole question is deserving of reconsideration, with a view to discussing the methods which the promoters of such a system would suggest and adopt, so as to avoid the usual "earthing" troubles, and thus get over the opposition of the electric supply companies.

Diagram for Combination Discharge Chest.



Valves shown Black are Open.

The Electric Lighting of Leith.

It is claimed by Mr. Bathurst that "earthed outer" wiring offers a solution which should be equally acceptable to all parties involved, namely, fire insurance authorities, supply station engineers, the electrical contractor, and the general public, which will obviate the main necessity for so many rules and regulations. Certainly, if Mr. Bathurst can put forward evidence and facts which will result in such a general understanding, he will have achieved more than the Czar's eirenicon. Of course, in fighting for the principle of "earthed outer" he fights for other systems than his own, but there seems no reason why the insulating steel conduit should not form as good an "earthed" system as concentric wires specially made up—and certainly a cheaper one. It remains to be shown how the system works in actual practice, as regards conductivity of the "outer" and absence of electrolytic troubles. As regards the former qualification, it must be noted that no special sockets or contacts are considered necessary as in other "earthed outer" systems, the ordinary screwed joints being made; and it is claimed that so long as the conduit is screwed into the coupling sockets *as tightly as possible*, the ohmic resistance is practically the same whether the screw threads have been cleaned or have been left very dirty and filled with compound. The italics are our own, and it would seem to us that it is just on that very condition that the whole question of conductivity rests. No doubt the final tightening up between the threads is sufficient to ensure the best of contacts, but here, again, we are at the mercy of the workman. One such joint not tightly screwed up, would, we are sure, result in dangerous overheating with perhaps serious consequences. Even if the dirt were burnt out by the heat the contact would not be improved, and it seems to us that overheating of the outer tube would quite neutralise all the benefits to be obtained by the incombustibility of the inner lining. Naturally the joints in the conduit form a source of added resistance also, but as the metal is more heavy at these points this resistance is partly neutralised, and it is claimed that, supposing under practical conditions we have a joint every 8 feet, the total increase in resistance in an ordinary run of, say, 50 feet from a distribution board would be only about one-half per cent., which is practically negligible. Here it would appear that the case quoted is rather below than above what might be actually experienced in practice, for it is not usual to have a run of 50 feet from a distribution board with only about six joints in the conduit. This is assuming only a straight length, whereas there are sure to be some bends and boxes with two joints each, as no one run would control one light only. It would therefore be quite legitimate to double the number of joints, which would make the volts dropped equal to 1 per cent., quite exclusive of what would be dropped from the main switch to the distribution board.

Such a drop would, we hardly think, be a negligible quantity under normal current, and would cause some difference in the light between light and full load. Besides this, it would mean a difference of potential on the "earthed outer" at two or more points in a building, which would tend towards creating an earth current if the building were damp, to say nothing of what might result if there were gas or water pipes touching the steel conduit; and it is not quite certain that the varnish which is laid on outside the insulating steel conduit would act as an insulator for any length of time. As a matter of fact, these coatings cannot be depended on in actual practice, as, if they are not chipped off in the store by the pipes being bundled together, they are damaged either in transit, whilst lying about in the building, or in erection. And as we have shown, it is quite possible to get electrolytic trouble in the house itself if there is any appreciable drop in the "earthed outer."

The next point to consider is what would be the effect of installing this system in various houses along the mains. Of course the term "earthed outer" is rather a misnomer unless the outer is actually "earthed" at various points in a house, but then to do this would be only to court the risks we have just drawn attention to, and which the insulating varnish is intended to obviate. We must, however, always assume the worse condition of things, and so we think we are justified in supposing it possible for the "earthed outer" to be in actual contact with earth at various points along the line. Supposing then that the street mains are most carefully protected everywhere from possible contact with earth—even by laying them in a trough filled with granite and bitumen, as at Brighton, we fail to see how small earth currents could be prevented from passing between the various houses, due quite possibly to nothing else than to the fall of potential along the mains in connection with their ohmic resistance. Certainly the chance of this happening would be more remote on a three-wire system if the "earthed outers" at every house were connected to the neutral main, but even then we can never obtain perfect balance in practice and an appreciable current is always flowing; and at a point where the "outer" made actual "earth" there would be small earth currents straying out more or less round the mains to the next "earthed" point, and so on. Or we might imagine a case of two neighbouring houses, one with an "earth" at the ingress point of the installation and the other with an "earth" at

the furthest light—both "earths," of course, on the outer casing. Under such a condition of things there might be possibly a difference of potential of 1 volt between two earthed points on one main not 50 feet apart. If the system were three-wire the earth current might be small, but if two-wire it would be greater, and in any case the earth would act as a feeder to the furthest light in the second house.

In putting forward all these criticisms, it must not be supposed that we wish to throw cold water on any scheme which would tend to cheapen and popularise the electric light, and be the means, possibly, of enabling us to dispense with a great many restrictions at present existing. It is only with the object of giving the promoters of such a scheme the opportunity of satisfactorily proving that the objections to "earthing" are based on unsound arguments, or can be overcome by the adoption of methods which they have up their sleeves, that we take up the position of the man in the street, and we do not see why—if such reasons can be adduced as to satisfy the electric supply authorities that "earthing" can be permitted with safety—it should not ultimately become the universal practice.

We understand that it is claimed that the insulating steel conduit, when installed on the "earthed outer" system is so simple to put up, that any ironmonger can take up the work with success, and we have seen circulars and testimonials to this effect. Of course, this would apply to any other system of electric wiring if the ironmonger liked to take it up, and, in fact, there are few suburban ironmongers now who do not call themselves electrical engineers. But screwing piping is one thing, and a proper appreciation of Ohm's law and electrical wiring is another thing, and we deprecate seeing the electric wiring trade thrown into the hands of ironmongers, drapers, and furnishers, where it generally becomes degraded, and gets a bad name. For we have insisted all along, and we repeat, that however simple and cheap a system of wiring may be as regards the material used, and the time taken to instal it, the work must be properly done, or else the most expensive materials are useless. And in order to do the work properly, skilled men should be employed who understand something more than the screwing of pipes, the "slinging" of casing, or the twisting of wires together, and who can be trusted to take as much interest in the proper execution of their work as in the advent of 12 o'clock on Saturday. If piping is to be "earthed," it must be screwed and fitted by electricians, not by gas-fitters, and it is therefore better on the whole to leave electric wiring in the hands of those who make it a speciality, and who do not have their attention diverted by the sale of saucepans, calico, or bedsteads.

The makers of insulated steel conduit are nothing if not go-ahead, at any rate in some of their theories, and for rank heresy and boldness of idea, we have come across nothing like the advance which they propose to make—at any rate in the wiring of houses. However, this is an age of progress, and we are startled by nothing new which we see or hear now, but for all those who wish to advance too quickly it must be pointed out that it is a curious thing that the more liberties and the more improvements we get, the more rules, laws and enactments are made to control them. To prove this it is only necessary to compare the statute book at the beginning of the century with the statute book as it is now.

However, to return to our subject. This indefatigable firm having evidently noticed with concern the recent rise in the price of India-rubber, and being also imbued with a due appreciation of the value of their insulating lining—seem to have been much troubled by the fact that people who use insulating steel conduit are still obliged to wire it with insulated wire. With apologies to the late Lewis Carroll, we might say :—

> The wireman and the carpenter
> Were at an installation,
> They wept like anything to see
> Such waste of insulation.
> 'If this were only cleared away,
> We'd need no regulation.'

And so, not content with wishing to cheapen the cost of house wiring by abolishing the return wires, they would wish to depend entirely on the internal insulating lining of their conduits, and use bare copper wire.

However, it is far from our wish to cast ridicule on such an idea. We must all keep up with the times, and if it can be shown that the insulating lining is a good insulator, and *continuous*, that it is absolutely non-hygroscopic, and that water will not condense within the conduits, that it is perfectly impervious to the arc, and that it is impossible to get a short circuit from the inside copper wire to the outside steel casing, we see no reason why a bare copper wire should not be employed in connection with an "earthed outer" as well as an insulated copper wire. We understand that a complete system on these lines has been worked out and protected, and there is no doubt that it opens a field for considerable economy in erection and material. The making of joints will be considerably simplified, there will be no insulation to strip or to tear, and above all, there will be no fuses to put the light out at inconvenient moments. The system will then be directly comparable with gas-piping in regard to cost, and will present certain advantages over gas in regard to risk.

Any overheating of a wire will be manifested by a bituminous smell, which will not explode, and it will then only be necessary to send for the electrician or ironmonger to discover the cause. A partial short circuit, or what is the same, a leak to earth from the inside wire, will be burnt out inside the conduit as soon as the arc has become too long, or a dead short circuit would frizzle up the inside wire instantaneously, and if this were not a main wire there would be no danger of all the lights in the house going out. Possibly the outer steel casing would not overheat dangerously in such a case, although the varnish might melt, and it would only be necessary to draw in a new piece of copper wire. Presumably, although we have no details as to this, there would be no soldered joints at all, all branches and connections being made from contact plates on porcelain bases in the tapping or joint boxes, and we can picture the gentleman of a scientific turn, when the light goes out at his dinner table, calling for a screwdriver and a piece of copper wire, and making a new connection from one box to another with almost as much ease as he did in the days when he had to insert a new fuse.

There is, however, one important point which occurs to us immediately : if the distribution system is adhered to (and everyone agrees that this is the best), it will be necessary to run a separate conduit containing the sub-mains to every floor from the main switchboards to the sub-boards, as obviously two bare wires controlling different floors could not be in the same conduit ; and the same applies to the conduits containing the distributing wires. It would, therefore, be necessary, in order to have a properly sub-divided switch control, to more than double the amount of insulating conduit, which would be a decided set-off against the saving in insulated wires.

Or this could be avoided if the Tree system were employed, when it would be necessary to have a switch to every light. But then this system is antiquated and inconvenient, and would entail a great deal of labour and material in connection with joint boxes in inaccessible places. Altogether we are rather in the dark about the matter, and our only desire is to have "more light." Anything in the nature of an advance in science must be well discussed before it can be considered an improvement, especially when it concerns our everyday life and our purses, and more particularly when it intends to sweep away many ideas which we have become used to, but which may be, after all, only fads. We have for so long, for instance, looked on a fuse wire as the slender thread that stands between perfect security and complete combustion that we mentally cling to it, and would as soon do away with it as buy a boiler without a safety valve.

All, however, except the most bigoted are open to convincement, and we think that the best method which Mr. Bathurst could adopt to arrive at this end would be for him to erect a lathe and plaster structure in an open place, wire it on his Bare-Copper-Wire-inside-and-Insulating-Steel-Conduit-System (or what, for short, he calls "Electric Piping,") connect it up to *his own* engine and dynamo, and then turn it over to a committee of electrical engineers, who, by judicious short-circuiting, would endeavour to set the structure on fire. In the meantime, we shall be glad to receive the views of those who have anything to say for or against the general principles put forward in this article, the present time being a highly propitious one for ventilating

ideas on these matters, and we trust that the discussion which we invite will tend towards the benefiting of the electrical and general community.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page 596.*)

Lincoln.—The Electricity Works Committee has received Mr. Vesey Brown's report on the question of electric power for tramways, and the plan showing the suggested routes has been considered. The Local Government Board has sanctioned the borrowing by the Corporation of £19,000 for electric lighting. The committee had resolved further that the electricity works, buildings, plants, stores, &c., be insured against fire in the sum of £10,000.

Milan.—On March 7th was opened a broad gauge electric railway between Milan and Monza, a distance of 8 miles. The carriages are of the American saloon type, with roofed platforms at the ends, and are supported on two bogies. The body of each carriage is 17·8 metres long, 2·5 m. high, 2·85 m. broad at the centre, and 2·15 m. broad at the platforms. Each carriage contains two compartments, one for smokers and the other for non-smokers, both together, 16 seats, and each second-class compartment is similarly sub-divided, 24 seats. Each of the platforms is divided into two compartments, of which the front is for the driver, and the inner to give access to the carriage. All the compartments are connected by a central corridor. The interior of the carriage is lighted by 10 16-candle-power lamps, two for each compartment of eight persons. The lamp in the driver's cabin has an opalescent shade, to better illuminate the road in front. The carriage carries, in addition, five signal lamps of 25 candles each. Besides a hand brake, each carriage has a Westinghouse brake arrangement, and in connection with the latter a compressed air receiver for actuating an alarm whistle. The outer axle of each bogie is connected by spur gear with a velocity ratio of 20 : 61 to the electro-motor. The motors are four-poled, with shunt magnets, in which the four coils are arranged in parallel. They are supported at one side by a cross-bar on the bogie frames and at the other by the axles of the wheels. Both supports are rendered elastic by spiral springs. Each carriage has a large and a small accumulator battery, the former of which supplies the motors and the pump motor of the Westinghouse brake, and the latter the electric lamps. The large battery contains 65 elements, which in series discharge at 275 to 235 volts. One charge suffices for three double journeys (48 miles), but at a stretch 60 miles can be done. The total weight of a carriage is 58 tons, 17 tons of which are due to the battery. The regular speed is about 30 miles per hour, but this can on occasion be increased to 37.

Plymouth.—It is hoped that the lighting plant will be completed within a month, and June is said to be the probable time for the opening of the electric tramways.

Sheffield.—The Tramways Committee, having considered the question of the trolley wire supplied by the British Thomson-Houston Company on the Nether Edge and Tinsley sections, have resolved:—"That if an expert, to be named by the Corporation, certifies that the wire put up by the British Thomson-Houston Company is as good for the purpose for which it is to be employed as wire of the description contracted to be supplied by Messrs. F. Smith and Co. for the Walkley section, this Committee will recommend the Council to accept the wire supplied—the British Thomson-Houston Company to bear the cost of the examination and report by the expert." The tender of the Wheeler Condenser and Engineering Company, of London, for the supply of two condensers for the Kelham Island power station at a total sum of £1,346 has been accepted. The Committee have also resolved:—"That as the regulations of the Board of Trade do not permit of persons standing at the ends of electric tramcars, the designs of the two sample cars to be ordered from Messrs. G. F. Milnes & Co. be modified, as shown on the design now produced by the tramways electrical engineer, providing seating accommodation for six smokers."

Southampton.—The Tramways Committee has recently submitted to the Council a report of the deputation which has visited various towns to investigate the electric traction system. The electrical engineer also reported on the Committee's recommendations, which he summarised as follows:—(1) That double lines be used wherever possible. (2) That side poles and centre poles be used in all positions favourable, but span wires are not recommended. (3) That fixed stopping places be adopted throughout the entire system, and that such stopping places be denoted on the lamp columns, at a distance of about 220 yards apart. (4) That the Corporation adopt a type of car similar to car No. 450, in use by the Liverpool Corporation, and that Messrs. Kincaid, Waller & Manville be instructed to prepare a specification with such modifications, including longitudinal seats, as may be necessary, and to obtain tenders to be submitted to the Corporation. (5) That in view of the recommendation to immediately order the rolling stock, Messrs. Kincaid, Waller & Manville be instructed to prepare plans and specifications for the necessary alterations to the Shirley depôt. (6) That time recorders be placed at each terminus, as at Dover. The report has been adopted by the County Council.

TELEGRAPH AND TELEPHONE NOTES.

The All-British Cable Scheme.—The *Times* says that at a private meeting of the Liberal Party at Ottawa the Government decided to ask Parliament to make a contribution towards the construction of an all-British Pacific cable. The general belief is that Canada will pay five-eighteenths of the cost, the Home Government a similar proportion, and the Australian Colonies four-ninths.

A later despatch from Ottawa says that Sir Charles Tupper, in the House of Commons on 12th inst., congratulated the Government on having reached a decision regarding the Pacific cable, and hoped that the arrangement was a satisfactory one. He had long held the view that the construction of the cable involved no obligation whatever upon Canada; in fact, the time was not far distant when the cable would be a source of revenue to the country. Sir W. Laurier expressed his appreciation of Sir Charles Tupper's complimentary remarks. The details of the arrangement with the Imperial Government and the Australian Colonies will not be forthcoming until the Dominion Government has introduced its Bill, which will be in about a fortnight.

Cable Rates to India.—On Wednesday, at a meeting of the Liverpool branch of the British Empire League, under the presidency of the Earl of Derby, a resolution proposed by the Lord Mayor was adopted, calling attention to the excessive rates charged on cablegrams between the United Kingdom and India, and requesting the Council and the League to use every means in their power to obtain a substantial reduction. In view of this resolution the report of the Indo-European Telegraph Company will afford interesting reading.

Proposed German Telegraph Line to India.—In connection with the cable concessions recently obtained by Germany from the Porte, which we understand form the beginning of a system of telegraph wires to be carried as far, at any rate, as Kuweit and Bushire, in the Persian Gulf, we learn that the German cruiser *Arcona*, from China, called at the head of the Persian Gulf, where she remained at Bushire and the neighbourhood for some few days.

The New Pacific Cable.—The Berlin correspondent of the *Standard* gives the following interesting details about the telegraph cable which the New York Pacific Cable Company proposes to lay between the United States and the Philippines. It is to be 11,000 miles long, is to touch at Hawaii and the Carolines, and connect the Southern Ladrones, being thence extended to Manila. The weight of the cable amounts to 28 tons per mile. A sixteenth part of the actual distance of the necessary connection will be allowed in excess, in order to make up for the unevenness of the sea bed. The cost is reckoned at $1,000 per mile, and as soon as Congress has given its consent to the slight concessions still demanded, the company is ready to commence work. The starting point according to the company's plans, will be Monterey in California, and the last point the town of Manila on the Island of Luzon. Two years will probably be spent on the completion and laying of the cable, but the survey of the route across the Pacific to Manila will probably be begun immediately. The importance of such a cable connection cannot be disputed. The new line, besides increasing the speed of communications, will reduce the cost from 60 to 70 per cent. A telegram of 40 words from Washington to Manila now costs $2 62 per word, and takes about two to three hours in transit. At least half a day, therefore, is necessary for an exchange of telegrams. With the new connection a telegram of the same length to Manila will cost at first only $30, and, according to the calculations of the Cable Company, would reach its destination in not more than half an hour. United States troops are quartered in all the islands named, and the advantages of rapid communication are obvious. Indeed, the heads of the Army and Navy Departments at Washington would themselves have to establish such a connection if Congress cannot come to terms with the New York Cable Company. The disinclination of the United States Government to lay the cable at its own cost is explained chiefly by the circumstance that the previous surveys in the Pacific are not yet sufficient to afford a clear comprehension of the technical difficulties. Another difficulty, hitherto, has been the want of intermediate stations in the Pacific, as the islands which would have served the purpose did not possess a government of their own. This hindrance is now, according to American opinion, removed. If Hawaii, Wake Island, Guano, and the Philippines can be utilised as landing places for the cable, there would be no extent of cable between these points so long as to constitute a difficulty. None of these sections would be as long as the French cable, which is laid from Brest to Cape Cod, on the coast of Massachusetts, and which is 3,250 miles in length. The longest section of the proposed Pacific cable would be that from San Francisco to Hawaii, amounting to only 2,098 English miles. From Hawaii to Wake Island is 2,040 miles; from Wake Island to Guano 1,290 miles; from Guano to Manila 1,520 miles. With regard to the depth of the Pacific, no trustworthy figures are as yet available. The difference, as compared with the Atlantic Ocean, is, however, not supposed to be very great. The cable recently laid from Hayti to the Windward Islands lies 18,000 feet deep, whereas the greatest depth between San Francisco and Hawaii does not amount to more than 18,300 feet. The greatest depth between Hawaii and Manila is put at 19,600 feet, but this calculation is not confirmed as yet by unbiased measurements. However, in the opinion of experts, there are no depths on the route of the projected cable which would greatly exceed those at which cables have already been laid in other seas. The question of the cable will certainly be an important item at the next Congress. Meanwhile the Naval Administration ought to have soundings taken along the projected route, so that Congress may have more accurate information about the technical feasibility of the cable.

Telegraphic Cable Communication.—In the House of Commons on Monday, Mr. Webster called attention to the present subsidies given to certain cable companies, and argued that it was desirable that all cable communication between the various parts of the British Empire should be under Imperial control. To various cable companies subsidies amounting to £94,241 were annually paid, and, without saying a word antagonistic to these companies, the pioneers in this mode of communication, he said we had now reached a time and condition of things when a better service could be established without any subsidy. Such was the opinion arrived at after conferences between the home Government and colonial Governors and Premiers; and, if Great Britain and the Dominion of Canada would defray two-thirds of the cost of a Pacific cable, the colonies of New South Wales, Queensland, and Tasmania would contribute the other third. Indicating the route of a message sent over the Eastern Extension Company's line from Australia to Canada, he showed how, by a Pacific cable, a distance of 4,000 miles would be saved, and the cost reduced from 8s. to 3s. a word. Such a line would, no doubt, have a preference, and take away some of the large profits of the Eastern Extension Company, but the projectors recognised that the company were entitled to compensation or a fairly-estimated purchase price. He showed, says the *Times* report, the points of connection of the proposed trans-Pacific line from Vancouver to Australia, and insisted on the advantages of a cable circling the globe with its connections on British territory everywhere. There would be no necessity to lay all the cables in one year. He believed the cables would be absolutely self-supporting. The cable rate to Australia had been reduced from 9s. 4d. per word to 4s. 9d., but if reduced further to 3s. no less than £190,000 a year would be saved to the mercantile community. The reduction would naturally lead to the expansion of commercial business with our colonies. The hon. member pointed out from the *Postal Guide* some of the striking anomalies and differences which exist in the cable rates to various parts of the world. The tariffs were practically prohibitive. No one sent a cable to a distant part of the world unless absolutely obliged by very pressing business. The great advantage of the system he advocated would be a double route of cables extending throughout the British Empire. If we did not construct these routes very quickly and take the advice of our colonies others would do it. The Americans had already made a survey of the Pacific, and the French had laid the first link of a chain destined to connect Australia with North America. The system, if carried out by the State, would be carried out in such a way as to give encouragement to business, because the State would endeavour to still further reduce the cable rates. Besides, the State could obtain capital at a cheaper rate than any company. A remunerative tariff would greatly increase facilities and reduce charges. Even if the Eastern Extension Company lost half its present profits it would still be a paying concern. The cables would be great auxiliaries from the Imperial defence point of view. It would be desirable, he maintained, to have direct lines of communication with Hong Kong, Shanghai, Cape Town, Simon's Town, Bombay, Madras, and other important coaling stations.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
French Company's cables—		
Paramaribo-Cayenne ...	Feb. 10th, 1899 ...	April 10th, 1899.
Cayenne-Pinheiro ...	March 10th, 1899 ...	...
Para-Maranham	April 10th, 1899 ...	...
Landlines.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	...
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Siberian landlines between—		
Blagowestschensk-Khabarowka.	April 8th, 1899 ..	April 9th, 1899.
Blagowestschensk-Khabarowka.	April 10th, 1899 ...	April 11th, 1899.
Blagowestschensk-Khabarowka.	April 12th, 1899 ...	...
Fao landlines between Bagdad and Bassora.	April 11th, 1899 ...	...

The Telephone Question.—On 10th inst. a meeting of representatives of the Corporation of Liverpool, the Dock Board, the Chamber of Commerce, and the Professional and Trade Associations in Liverpool passed resolutions recording their great dissatisfaction with the Government scheme for dealing with the telephones, and expressing the opinion that it is desirable, not only in the interests of trade and commerce, but of the whole community, that the telephone system of the country should be placed under the control of a Government department, so as to have it extended, developed and cheapened with the least possible delay. The meeting endorsed the resolutions passed by the City Council and the Liverpool Chamber of Commerce. Sir Thomas Hughes, chairman of the Parliamentary Committee, moving the resolution, said that the Government scheme to give the Liverpool Corporation power to compete with the National Telephone Company and surrender the system to the Government in 1911 at a price which the Government think fit to fix was an undertaking upon which the Corporation would not be likely to embark. The Government should now force the company to accept reasonable terms, or be subject to effective competition. Copies of the resolutions are to be forwarded to Ministers, the local members of Parliament and to county borough authorities and chambers of commerce generally.

Wireless Telegraphy.—Now that this subject has come into such prominence and public attention, it may be as well to remember that so long ago as 1831 James Bowman Lindsay, of Dundee, conceived the idea of conveying electric signals across water without the use of connecting wires, and actually did so convey them across the Tay more than 40 years ago. He even went so far as to express the opinion that signals might be so conveyed across the Atlantic, and in the printed proceedings of the British Association for 1859 his method of so doing is briefly described. Lindsay was an extraordinary man. From a humble weaver he advanced to the position of science teacher, and in the advertisement announcing the opening of classes, which appeared in the *Dundee Advertiser* of April 11th, 1834, he predicted the electric light and the use of electricity for driving machinery and other purposes. In 1835 he publicly exhibited an electric lamp in Dundee. Besides the successful efforts of Lindsay, in 1856 Dr. O'Shaughnessy, Director and Superintendent of Telegraphs in India, sent messages across the River Sone, in Bengal, without the use of connecting wires or cables.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—April 23rd. Tenders are being invited until the 23rd inst. by the municipal authorities of Brunn for the supply of four Edison dynamos (model K) of 200 amperes and 110 volts capacity, one small and two large Gramme dynamos for arc lighting, three boilers of the Dufuis type to work at a pressure of 105 lbs. and one 100-H.P. steam engine with Colmann valve gear. Tenders to be sent to Der Magistrat, Brunn, whence particulars may be obtained.

Battersea.—June 7th. The Vestry want tenders for the supply of mains, water-tube boilers, steam dynamos and engines. See "Official Notices" this week.

Belfast.—April 20th. The Electric Committee want tenders for mechanical stokers, economisers, pipe work and condensing plant. See our "Official Notices" March 31st.

Belfast.—April 27th. The Electric Committee wants tenders for road-work and laying cables, &c. See "Official Notices" this week.

Dublin.—April 20th. The Corporation is inviting tenders for the supply, fitting, and connecting up of electric light fittings, suitable for a 200-volt supply; also taking down existing fittings, for which allowance is to be made. Particulars from the City Engineer on payment of one guinea.

Edinburgh.—April 24th. The Corporation want tenders for a 12 months' supply of steam coal, arc lamp carbons, cast-iron pipes, &c. See our "Official Notices" this week.

Epsom.—May 8th. The District Council wants tenders for various plant for its electricity undertaking, including boilers, dynamos, boosters, batteries, switchboard, crane, mains and road-work, arc and incandescent lamps, and for the lighting of the station. See our "Official Notices" April 7th.

Hampstead.—May 18th. For the purpose of extensions at the electricity works, the Vestry wants tenders for two 500-kw. steam alternators, five switchboard panels, boilers, feed water heaters, Weir's feed pumps, a 50-kw. exciter, water softening plant, air pump and condenser, Green's economiser and overhead crane. See "Official Notices" April 7th.

Kingston-upon-Hull.—April 25th. The School Board wants tenders for an electric light installation for the Central Higher Grade School, and School of Science in Brunswick Avenue, Beverley Road. Particulars from Mr. O'Donoghue, clerk, School Board Offices, Albion Street, Hull.

London.—April 24th. The London County Council require tenders for the supply of engineers' goods and electrical stores. Full particulars may be obtained on application to the Clerk to the Council, County Hall, Spring Gardens, S.W.

Peterborough.—April 20th. The Corporation wants tenders for Lancashire boiler, steam dynamos, balancers and boosters, switchboard, battery, piping, cables, &c.

Poplar.—April 25th. The Board of Works wants tenders for engine and boiler house plant, battery equipment and street lighting. See "Official Notices" March 17th.

Reigate.—May 1st. The Town Council wants tenders for water-tube boilers, pipe work, two 100-kw. and one 30-kw. steam alternators, overhead crane, sub-station equipment, switchboard, mains, lamp-posts, &c. See our "Official Notices" April 7th.

St. Helens (Lancs.).—April 19th. Tenders are wanted for the construction of about six miles of tramways in sections, for the Electric Supply and Tramways Committee. Plans and form of tender on application to Mr. Geo. J. C. Broom, M.I.C.E., borough engineer, on payment of £2 2s., returnable as usual.

South Shields.—April 20th. The Corporation is inviting tenders for the supply of steam and water pipes and valves, and a 15-ton overhead traveller. Specifications, &c., from the Borough Electrical Engineer.

Spain.—April 20th. The municipal authorities of Santiago are inviting tenders for the supply and erection of the plant for a central power station to be erected near the town to utilise the water-power of the River Tambre for the generation of electrical energy for lighting and power purposes. Particulars may be obtained from, and tenders are to be sent to, El Presidenté del Consejo de Administracion Santiago, Spain.

Stockport.—April 19th. The Gas and Electricity Committee wants tenders for an electric storage battery of 130 cells, having a capacity of 750 ampere-hours. See our "Official Notices" April 7th.

Sunderland.—April 21st. The Guardians require tenders for the necessary wiring, lamps, &c., as well as all cables, stoneware casings, and boxes in connection with the lighting by electricity of the new Workhouse Infirmary. Plans and specification at the offices of Messrs. W. & T. R. Milburn, architects, 20, Fawcett Street, Sunderland.

Sutton and Howth (Ireland).—April 20th. The Great Northern Railway Company wants tenders for works in connection with their line between Sutton and Howth, near Dublin, including the supply and laying of feeders, returns, &c., rolling stock, overhead construction, battery and booster, &c. See our "Official Notices" March 24th.

West Ham.—April 21st. The Council want tenders for two 1,500-I.H.P. engines, and two 800-kw. alternators and exciters, or two 800-kw. 1,500-I.H.P. steam alternators and exciters. See our "Official Notices" March 31st.

West Hartlepool.—April 15th. The Corporation invites offers from those prepared to undertake free wiring of premises. See our "Official Notices" March 31st.

CLOSED.

Aberdeen.—The Tramways Committee has accepted, in connection with the Woodside electric tram section, the offer of Messrs. M'Cartney, MacElroy & Company for the overhead line construction, cars, and accessories, switchboards, and instruments at a total cost of £7,793. The offer of the British Insulated Wire Company to supply feeder, pilot and test cables at a cost of £5,340 was accepted. The total cost of the construction of the line will be £31,218, a sum which is considerably under the estimated cost.

Canterbury.—At the last Council meeting the Lighting Committee and Mr. Hammond recommended that the following tenders, subject to the consent of the Local Government Board, be accepted for the extensions:—Alderman Mason, the Chairman of the Committee, explained that, as prices in the electrical world were rising by leaps and bounds, it was thought desirable to secure contracts without delay, subject to the approval of the Local Government Board. They might thus have some prospect of getting the machinery delivered within the space of 12 months hence. The report was confirmed. The tenders for the switchboard extension, Section C, are still under consideration.

Section.	Plant.	Name of firm.	Amount.
A.	Boiler house plant.—One boiler complete, mechanical stokers.	R. Taylor & Sons, Marsden	£707 10
B.	Engine house plant.—1 150-kw. steam dynamo; steam, exhaust, &c., pipes; condenser, and accessories; centrifugal pump and motor; tools, painting, &c.	India-Rubber, Gutta-Percha and Telegraph Works Company, Limited, Silvertown	2,622 0
D.	Underground mains, cables, &c.	Western Electric Co., North Woolwich ..	1,314 0

Dundee.—The Tramways Committee on 4th inst. opened the tenders for the supplying of electrical plant for the tramways. The tenders were for the combined compound engines and dynamos, a triple expansion engine and dynamo, and also four Lancashire boilers. It is understood that the successful tenderers were: For the two compound engines and dynamos, and also for the combined triple expansion engine and dynamo, Messrs. Lowdon Brothers, Dundee. The aggregate price of both contracts is, it is understood, about £9,700. With regard to the four Lancashire boilers, a tender of Messrs. Cooper & Greig has been accepted. It is understood that the price of the boilers, with flues and seatings combined, is £3,058.

Gloucester.—The Town Council at their last meeting had under consideration the reports of the Electricity Supply Committee and the consulting engineer, Mr. Robert Hammond, on the tenders submitted for the additional plant required for the Municipal Electricity Works, when the following were accepted:—

Section.	Plant.	Name of firm.	Amount.
G.	Public arc lighting	British Insulated Wire Company, Limited, Prescot	969 16
I.	Condensers and air-pumps ..	Blake & Knowles, Limited, London ..	567 0
J.	Cast-iron water pipes	Stanton Iron Works Company, Limited, Alfreton	400 0
K.	Steel steam, exhaust feed and drain pipes.	Ashton Frost & Co., Limited, Blackburn	1,185 0

Hammersmith.—Tenders as under have been accepted by the Vestry:—Messrs. Babcock & Wilcox, for supply of three water-tube boilers, according to specification, £3,320; Messrs. J. Musgrave and Co., for supply and erection of two vertical engines, according to specification, £7,284; Messrs. Siemens Bros., for supplying and fixing two alternators, according to specification, £5,684; Messrs. Callender, for supply of cables, according to specification, at schedule of prices; Mr. James Ritchie, for supply of cast-iron pipes, according to specification, at schedule of prices.

Hereford.—The Town Council have accepted the tender of Messrs. W. P. Lewis & Co., for the erection of electricity works buildings at £2,752. It is hoped that the supply may be available by early in October.

FORTHCOMING EVENTS.

Friday, April 14th.—At 9 p.m. Royal Institution. "Earth Currents and Electric Traction," by Prof. A. W. Rücker.

Thursday, April 20th.—At 8 p.m. Institution of Civil Engineers. The seventh "James Forrest" lecture, by Prof. J. A. Ewing, subject "Magnetism." Lecture to be repeated on Friday, 21st inst., at 4 o'clock.

Friday, April 21st.—At 5 p.m. Physical Society. Agenda:—1. "On the Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside." By Mr. C. S. Whitehead, M.A. 2. "Demonstration of Richards's Method of Standardising Thermometers." By Mr. R. A. Lehfeldt, D.Sc.

NOTES.

The Helios Electrical Construction Company.—This is the latest addition to the large electrical manufacturing concerns in this country, and will shortly open offices at 49, Cannon Street, E.C. The Helios Company, whose works are equipped with the most modern machine tools and appliances, are in an exceptional position with regard to quick delivery of every kind of plant required for lighting and power purposes. Amongst their standard specialities are a whole line of 200 and 500-volt motors, open and enclosed, and a line of single-phase motors that will start on full load without disturbing the supply service. The company has appointed Mr. A. C. Eborall chief engineer. It may be expected that Mr. Eborall, who partly received his practical training at the works of Messrs. Brown, Boveri & Co., and who has devoted much time and attention to single and polyphase work, will be quite at home with the firm in question, who have done an enormous amount of work in these directions on the Continent.

Brussels Electrical Exhibition.—The Brussels Electrical Exhibition is to be opened by the King on June 1st. Owing to the whole of the space having been applied for the Minister of Telegraphs has granted the entire building of the magnificent "Nouvel Hôtel des Telephones," so that the area for space will be doubled. This building will be turned into a Central Telephone Exchange after the Exhibition, and will be one of the largest in the world; the telephone wires will be gradually put underground. The entire system of telephones now in Belgium belongs to the Government, and is under the control of the Director-General of Posts, State Railways, and Telegraphs. The Minister of State Railways, Posts and Telegraphs has issued a decree stating that all goods for the Exhibition shall enter the country *free of duty*, and that the State railways will reduce the carriage on their lines for same by 50 per cent. A special circular will be issued and sent later on to all exhibitors giving the exact conditions of transport.

Royal Institution.—At a meeting on Monday the special thanks of the members of this Institution were returned to Sir Benjamin Baker, K.C.M.G., for his donation of £50, and to Nobel's Explosives Company for a donation of £105, to the Fund for the Promotion of Experimental Research at Low Temperatures. The first Hodgkins gold medal given by the Smithsonian Institution has been conferred on Prof. Dewar for his work on the liquefaction of air.

The Copper Market.—Messrs. H. R. Merton & Co.'s last fortnightly report upon the state of the copper market is not quite so favourable, from the consumers' point of view, as the preceding one. The price of G.M.B.'s has advanced 20s. per ton during the fortnight ending March 31st, and at the latter date stood at £70 per ton. Supplies have, however, been considerably in excess of deliveries, and during the month of March the stocks of refined copper in European ports, and afloat thereto, have increased from 24,326 tons to 28,497 tons, a gain of 4,171 tons. This increase has been chiefly in the stocks held in London and at French ports. The total supplies in March were 21,225 tons as compared with 13,716 tons in February. Of this total America has sent 11,463 tons; Spain and Portugal, 2,285 tons; Chili, 1,800 tons; Australia, 1,400 tons; and other countries, 4,277 tons. The latter is the only one of these totals which is above the average; but it is reassuring to find that countries outside the ring of copper producing countries are increasing their shipments to Europe, since it lessens the chances of success for those who are attempting to corner the market. On the London metal market there seems to be an impression that at present much of the buying is of an interested character and is merely in response to advices from New York speculators. Our advice to buyers is therefore to simply cover their requirements, and to trust that all attempts to corner the market will fail owing to the increasing number of producing mines. No new copper mining companies have been floated since our last note on the subject. Since December, 1898, we have, however, given details of the prospectuses of six new mining companies, having an aggregate capital of £2,430,000, namely :—

1. Le Roi	£1,000,000
2. Copper Corporation of Chili	200,000
3. Mid Moonta	130,000
4. Mount Lyall	500,000
5. Copper King	350,000
6. Balla Balla	250,000

The development of these mines with the new capital must, in time, have a marked influence upon the world's supply of copper. With reference to the renewed attempts by New York speculators to force up the price of the metal, we may call attention to the following condemnation of such attempts, which recently appeared in one of the New York technical papers :—

> With the improved conditions of business and the active demand for the metal, both here and in Europe, in electrical, shipbuilding, and other work, a rise in price was to be expected. Until quite recently the improvement was a natural and legitimate one, and the producers could derive only benefit from it. Now, however, the speculators have taken hold, and the intention is said to be to force the quotations up to 20 cents, which is quite possible under present conditions. The inevitable result will be to curtail consumption and to turn manufacturers to other metals wherever they can possibly be used. Moreover, there will be a general opening up of old mines which have been abandoned as unprofitable and an exploitation of new ones, which will be sure to increase production to a point beyond the real demand. The inevitable reaction will be disastrous to speculation and injurious to investors in new and old mines which cannot be worked at a profit under ordinary conditions. The moderate advances justified by trade conditions would have benefited our mines far more than any temporary advantage they may gain from the present wild speculation.—*Engineering Journal.*

With these remarks we entirely agree.

Wireless Telegraphy.—The *Times* says that a French warship, upon which experiments will be made with wireless telegraphy, has arrived at Calais, and the experiments will be made between different points in the English Channel and the South Foreland. The French Government has under consideration the question of adopting the system generally for use in the navy.

On Saturday last a committee from the General Post Office Telegraph Department went down to the South Foreland to inspect the Marconi system by which messages have been sent across to Boulogne. It is stated that Mr. Marconi will try his system from the Newhaven cliffs to the Dieppe cliffs. It is also stated that the Wireless Telegraphy Company has been approached by the representative of a proposed syndicate which desires to acquire the sole rights of establishing wireless telegraphic communication between England and America. The proposal is understood to be made in all seriousness, and there is every possibility of it being carried to a practical issue if the company and the syndicate can only come to terms. The directors of the company will consider the matter shortly.

Personal.—Mr. D. F. Sugrue, superintendent for South Wales of the British Electric Traction Company, has been appointed a magistrate for the borough of Swansea.

It is announced that the Board of Trade have appointed Mr. A. P. Trotter (at present Government electrical engineer for Cape Colony) to be electrical adviser to the Board, in place of Major Cardew, who has resigned.

Mr. Martin C. Olsson has resigned the position of assistant engineer at the Belfast electricity works, he having made arrangements to join the firm of Messrs. Coates & Son, Limited, of Belfast and Dublin.

Messrs. Veritys, Limited, have appointed Mr. M. B. Cotterell to the management of their branch at Manchester, at present quartered at 29, Princess Street. The district covered includes the North of England, Ireland, and part of Wales. Mr. Cotterell, who first joined Messrs. Veritys in 1887, has for the past 2½ years held the position of assistant general manager at their works at Aston. On leaving the works Mr. Cotterell was presented with a very handsome testimonial by the staff and employés. Mr. A. A. King remains Messrs. Veritys' chief outside representative in the North.

Mr. Henry Courteen, recently the managing director of Brown & May, Limited, left the service of the company on the 30th ult. Mr. H. A. B. Trevor has succeeded him as general manager.

Mr. H. Haskayne, Assistant Superintending Engineer of Postal Telegraphs, Cardiff, has been appointed superintending engineer, Manchester, in the place of Mr. J. Doherty, superannuated.

The Telephone Service.—Correspondents of the *Times* continue to express their views on the Telephone Service. General Webber repeats the observations which he has made from time to time; Sir John Lubbock quotes Mr. Varley's articles from our columns, and fears that the Telephone Bill would involve pecuniary loss, and be a serious check to the progress of applied science; Mr. H. D. Kimber, a member of the Wandsworth District Board of Works, takes exception to municipal exchanges, and recommends "the entire system being in one and the same, and that the paramount authority," concluding with the observation :—"It cannot surely be gainsaid that the ideal national service of telegraphs must be one that is built up by one master mind as one entire and comprehensive system, and worked as such under one management." Mr. F. Faithfull Begg contends that it would be wise to recognise now and at once that immediate consolidation is the only reasonable plan, and that by that means alone can endless public inconvenience and vast ultimate waste of money be avoided; Mr. Provand replies to some of the points raised by Sir John Lubbock, and asserts that the whole history of the National Company proves that it is incapable of competing with any properly-organised company, it knows well it can only succeed as a monopoly. General Webber sends a further communication in reply to the other correspondents, and finds that they have not studied their subject even so far as to show that they have read his letters to the *Times* in 1898; Mr. F. E. Baines, late Surveyor-General (Telegraphs) G.P.O., advocates purchase of the company's plant, and Sir John Lubbock makes a short reply to some points raised by Mr. Begg.

Lectures.—A special evening course of lectures and laboratory work on "Alternating Currents" commences on May 1st at King's College.

On 28th ult. Dr. Fison delivered the third of a series of four lectures on electricity at Bournemouth. His subject was "The Dynamo." The last of the series will be on "Wireless Telegraphy."

Before the Aberdeen Mechanical Society, on 4th inst., two papers were read by associate members competing for the prizes offered by Mr. Walter Dixon, electrical engineer, of Glasgow. Mr. G. F. Rose secured the first prize for a paper on "Electricity in Coal Mining," and Mr. G. Anderson second prize for "Electric Welding."

Presentation.—Mr. John Pilling, who has been appointed borough electrical engineer at King's Lynn, was last week made the recipient of a handsome presentation from the staff at the Bolton Corporation electricity works, where he was chief assistant. The presentation took the form of a handsome marble clock, with side ornaments.

Wages Dispute in the Engineering Trade.—On 6th and 7th inst. a conference of the executive committees of the National Federation of Engineers' Employers and the Amalgamated Society of Engineers was held at the Hôtel Métropole, London, for the purpose of considering a wages dispute in the trade which has arisen in Mid-Lancashire, Halifax, and Newcastle. The terms of settlement decided upon at the conclusion of the engineers' great strike some 15 months ago were that all cases of local disagreements between the masters and men should be submitted to the executive committees of their respective organisations. Accordingly the committees met to discuss the first dispute of any importance which has occurred since the general strike. Mr. R. Sinclair Scott presided. The dispute has occurred through the operatives in Mid-Lancashire, Halifax, and Newcastle-on-Tyne asking for an increase in wages of 2s. a week. The masters refused to accede to the request, and the matter was referred to the committees. The dispute affects about 6,000 hands. Information was communicated to the press at the close of the conference that a recommendation had been jointly agreed upon, which, in due course, would be submitted to the parties concerned. The terms were not divulged.

Obituary.—We learn with considerable regret of the very sudden death of Mr. Andrew J. McGeoch, a partner in the firm of William McGeoch & Co., brass founders and electrical fittings manufacturers. Mr. McGeoch was staying at Bournemouth over Easter with his family, and on Tuesday last week, while returning to his boarding house, he was seen to fall. A medical man, who was near at hand, declared that life was extinct when he saw the deceased. After the fall it seems that he never spoke again. The medical evidence showed death to be due to syncope from failure of the heart's action. The deceased was over 50 years of age and was previously in good health.

We regret to announce that Mr. F. L. Hutchins, of the firm of Messrs. Murray, Hutchins & Stirling, died at his London residence on the 6th inst. in his 72nd year. For 33 years Mr. Hutchins, as legal adviser to the India-Rubber, Gutta-Percha, and Telegraph Works Company, had been closely connected with electrical development in its telegraph, telephone, light, and power applications. An able man, a kind colleague, his loss will be severely felt by the Silvertown Company, by his partners, and by the friends he leaves behind. To his family we tender our sympathy.

Machine Tools.—Before the Society of Arts on Monday, 10th inst., Mr. Ewart C. Amos read a paper on the above subject.

The Paris Exhibition.—We are informed that a sub-committee consisting of the following gentlemen has been appointed in connection with the British Electrical Section of the Paris Exhibition of 1900 :—Mr. W. H. Preece, C.B. (chairman), Sir Henry Mance, C.I.E., Mr. Alexander Siemens, Mr. Henry Edmunds, Mr. J. J. Swan, Mr. H. Thomson Lyon (secretary).

Sentence.—Mr. Justice Grantham on Wednesday sentenced Claude T. J. Vautin, metallurgical chemist, to six months' imprisonment without hard labour. The case has been referred to in the Review on several occasions.

Hooper's Core.—It is of interest to hear that Messrs. Hooper's Telegraph and India-Rubber Works, Limited, are shipping to China next week, for the Great Northern Telegraph Company, a further 230 tons of two-core and single-core cable containing Hooper's core made in 1870-71, which has now been re-sheathed. Tests have shown it to be as good as when first made.

The Castner-Kellner Judgment Reversed.—The Court of Appeal yesterday gave judgment in the appeal of defendants in the case of the Castner-Kellner Alkali Company, Limited, *v.* The Commercial Development Corporation, Limited. The case was reported in our issues of March 3rd and 10th. The Master of the Rolls and Lord Justice Rigby were of opinion that the judgment ought to be reversed, and judgment was entered for the defendants accordingly. Lord Justice Vaughan Williams disagreed.

The Penalty of Greatness.—The editor of the *Syren and Shipping* has entered a timely protest against the publication in the daily press of a lot of theoretical and nonsensical twaddle from hysterical survivors when such disasters as that of the *Stella* arise. But the worst offenders are the writers on the editorial staffs of these very papers. Take, for instance, the *Pall Mall Gazette* of last Monday. Discussing wireless telegraphy, the scribe tells us that trials are now being made with a moving vessel and a fixed point on shore, and if they come off a vessel will always be able to know where she is in a fog.

> A Marconi station on the Casquets, a receiver on the approaching *Stella*, and there will be no more disasters like Maundy Thursday's.

Such is the simple safeguard of the *P.M.G.*, and Marconi has much to answer for. Nevertheless, as Marconi's signals will affect his receiver up to a distance of 30 miles, how is the poor benighted fog-bound captain to know whether he is within that distance of land or only 30 yards from the signalling station ? And how is the operator, who can see nothing, to tell the captain whether he is close in shore or miles away ? No, the *P.M.G.* does not go far enough. It must have a skilled electrician in addition to the telegraph operator, a man who can exactly measure the resistance of the ether between ship and shore, if the skipper will only make sure that his end of the ether is properly "earthed," and then by a simple calculation we arrive at the precise distances between station on shore and vessel at sea. We commend this addition to our contemporary's admirable proposal with the deference we invariably feel for the *P.M.G.* As a correspondent to the *Westminster Gazette* aptly puts it :—

> With the growing efficiency of journalism there has arisen a tendency, among writers of no practical experience, to rush into the discussion of technical affairs with an air of omniscience which would sit awkwardly even on competent men.

Appointments Vacant.—The Belfast Electric Committee is wanting an assistant electrical engineer at £150 per annum. See "Official Notices" this week.

The Sheffield Corporation wants a mains superintendent at £250 a year. See our "Official Notices."

Electric Lighting at Buckingham Palace.—In the House of Commons on Monday Mr. Caldwell asked when the installation of the electric light at Buckingham Palace, which was estimated to cost £11,000, and on which £3,500 had already been expended, was to be completed. Mr. Akers-Douglas, replying to the various questions asked, explained that the amount which they were taking this year for the extension of the electric light in Buckingham Palace was an amount on account. A further sum would probably have to be expended before the full service was complete. This matter was very carefully gone into by a committee some two or three years ago from the point of view of safety from fire, and it was decided that, as far as possible, electric light should be used.

The Education of English Workmen.—The giving out of the Atbara Bridge contract to America provides "Viator" with a text for a letter to the *Times* on the above subject, in which he compares the education of the British workman with the American and Continental, much to the disadvantage of the first named. He quotes the statement of an English electrical manufacturer, whose workmen

> have not the necessary library education to qualify them to become first-rate workmen. They have left school at 11 or 12 years of age, and they read with difficulty, and hardly write more than their names. They could not follow the simplest lecture on a scientific subject, and as to reading a manual, it might as well be in Hebrew.

At Zurich, says "Viator," after a lad of 14 has entered a technical or trade school, he is obliged to spend two mornings a week at a literary school, so as to keep up and improve his general knowledge. A deplorable state of things exists, he says, in the trades of opticians, watchmakers, dentists, jewellers—all beaten out of the field by French and German educated artizans.

Appointment.—We understand that Mr. Stephen Kirkwood, of Edinburgh, has been appointed assistant engineer to the Lancaster Corporation electricity works.

NEW COMPANIES REGISTERED.

Neild's Sleeve Electric Joint Syndicate, Limited (61,364).—This company was registered on April 4th, with a capital of £5,000 in £1 shares, to adopt an agreement with Harry W. Neild, and to carry on the business of electricians, mechanical engineers, and makers of electrical apparatus, telephone and telegraph instruments, cables, wires, &c. The first subscribers (each with one share) are:—James Myerson, 112, Leighton Road, Kentish Town, clerk; Wm. H. Harton, 53, Tytherton Road, Upper Holloway, accountant; Harry W. Neild, 27, Tyson Road, Forest Hill, engineer; C. C. Christopher, 5, Victoria Road, Norwood, gentleman; Frederick C. Pallett, 87, St. John's Road, Upper Holloway, registrar; Charles H. L. Alder, 6, Lancaster Place, Hampstead, solicitor; H. W. Allason, 194, Holland Park Avenue, W., gentleman. Registered without articles of association.

Ferrolite Electric Syndicate, Limited (61,376).—This company was registered on April 5th, with a capital of £30,000 in £1 shares (8,000 "A" and 22,000 "B"), to acquire Provisional Patents Nos. 22,070, 23,306 and 23,307 of 1898, granted to Charles Levetus for "improvements in and relating to galvanic and other batteries," to adopt an agreement with Edward L. and Charles Levetus, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The first subscribers (each with one share) are:—Edward L. Levetus, 37, Victoria Street, Birmingham, agent; Algernon L. Collins, 31, Lawrence Lane, Cheapside, solicitor; Vaughan Page, Haldon House, Mottingham, Eltham, Kent, clerk; Henry C. Sawyer, Stanford, Muswell Avenue, Muswell Hill, N., clerk; John M. Bell, 18, Cambridge Road, Eastbourne, book-keeper; Ernest J. White, 12, Delamere Street, Paddington, clerk; George L. Laming, 161, Whittington Road, Bowes Park, N., clerk. The first directors (to number not less than four nor more than seven) are Hymen Levetus and Edward L. Levetus, who may appoint other directors; qualification, £500; remuneration as fixed by the company.

Young & Marten, Limited (61,380).—This company was registered on April 5th, with a capital of £275,000 in £1 shares (150,000 6 per cent. cumulative preference), to acquire the business carried on by Harry H. Marten, at Stratford, Leytonstone and Walthamstow, in Essex, at St. Andrew's Wharf, Millwall, Middlesex, and elsewhere, as "Young & Marten," to enter into an agreement with the said vendor and to carry on the business of iron and brass founders, metal workers, boiler makers, lead smelters, machinists, fitters, mechanical, electrical and sanitary engineers, stove, grate and range manufacturers, motor car and cycle manufacturers and dealers, rubber manufacturers and merchants, oil and colour merchants, &c. The first subscribers (each with one share) are:—James Clark, Scoresby Street, Blackfriars Road, S.E., glass merchant; Ernest Marten, Tylney House, Eagle Lane, Snaresbrook, clerk; Frank W. Marten, Tylney House, Eagle Lane, Snaresbrook, clerk; Edward M. Edwards, 162, Romford Road, Stratford, E., manager; Benjamin Carter, Woodford Road, Leytonstone, E., salesman; Richard Letby, 55, Darenth Road, Stamford Hill, N., traveller; and Percy B. Wood, 403, Romford Road, Forest Gate, E, cashier. The first directors (to number not less than three nor more than five) are Harry H. Marten, chairman, Frank W. Marten, Ernest Marten, Edward M. Edwards and James Clark; qualification, £500; remuneration as the company may decide.

Poole and District Electric Traction Company, Limited (61,382).—This company was registered on April 5th, with a capital of £100,000 in £10 shares, to adopt an agreement with the British Electric Traction Company, Limited; the Bournemouth, Poole and District Light Railways (Electric) Company, Limited, and Wm. Murphy, and to carry on the business of tramway and light railway proprietors, carriers, electricians, electrical engineers and contractors, suppliers of electricity, electrical apparatus manufacturers, &c. The first subscribers (each with one share) are:—Emile Garcke, managing director; Geo. Stevens, secretary; Charles H. Dade, assistant secretary; Stephen Sellon, civil engineer; and Charles H. Gadsby, engineer, all of Donington House, Norfolk Street, W.C.; Wm. M. Murphy, 39, Dame Street, Dublin, public works contractor; John Lewis, 40, Claylands Road, Clapham, S.W., clerk. The first directors (to number not less than three nor more than six) are to be nominated by the subscribers; qualification, £100; remuneration as fixed by the company. Registered office, Donington House, Norfolk Street, Strand, W.C.

Longford Wire Company, Limited (61,384).—This company was registered on April 6th, with a capital of £100,000 in £1 shares, to acquire the business of the Longford Wire, Iron and Steel Company, Limited (in liquidation), and to carry on the business of wire drawers, wire weavers, metal workers, mechanical and electrical engineers, machinists, boiler makers, millwrights, iron and steel converters, &c. The first subscribers (each with one share) are:—Edwin Woods, 13, Wilson-Patten Street, Warrington, engineer: John Geddes, 19, Bold Street, Warrington, tea merchant; Richard T. Fairclough, Barry Field, Latchford, Warrington, miller; John R. Young, 40, Sankey Street, Warrington, chemist; John L. Tunstall and Charles D. Parkinson, Bewsey Chambers, Warrington, chartered accountants; Wm. Richardson, Marson Street, Warrington, coal merchant. The number of directors is not to be less than three nor more than seven; the first are John Geddes, J.P., Charles J. Holmes, J.P., John L. Tunstall, Richard T. Fairclough, J.P., and James F. Dutton; qualification, £200; remuneration, £30 each per annum and a share in the profits.

Chatsworth Arc Lamp and Electric Lighting Syndicate, Limited (61,392).—This company was registered on April 6th, with a capital of £25,000 in £1 shares, to acquire certain British and foreign rights granted to Haldane G. Cotsworth in connection with the manufacture of arc lamps, an 100-hour enclosed arc lamp, a 40-hour double carbon lamp, and a photographic lamp, to enter into an agreement with Arthur Ormsby, and to carry on the business of electricians, engineers, lamp makers, and suppliers of electricity. The first subscribers are:—Haldane G. Cotsworth, 125, Merton Road, Wimbledon, electrical engineer, 10 shares; Alfred Haynes, 42, The Broadway, Wimbledon, grocer, 5 shares; Geo. A. Wright, 28, Belle Vue Road, Wandsworth Common, S.W., secretary, 5 shares; Chas. G. L. Cator, 7, Southwick Place, London, secretary, 10 shares; Alexander Gascoine, 124, Chancery Lane, W.C., engraver, 5 shares; Arthur Mackenzie, 23, High Street, Peckham, secretary, 1 share; P. C. J. Macphee, Merton Park, Surrey, gentleman, 1 share. The number of directors is not to be less than two nor more than six; the subscribers are to appoint the first; qualification of first directors, 10 shares; of others, 150 shares; remuneration, £1 each per board meeting attended. Registered office, Arundel House, Arundel Street, Strand, London, W.C.

Edison-Bell Automatic Phonographs (Western Counties), Limited (61,408).—This company was registered on April 7th, with a capital of £11,000 in £1 shares, to acquire a license from the Edison-Bell Consolidated Phonograph Company, Limited, for the sale, exhibition, and use of the Automatic Phonograph, with the penny-in-the-slot attachment in Somerset, Gloucester, (part of) Devon, Monmouth, Glamorgan, Carmarthen, Pembroke, Cardigan, Brecon, and Radnor, and to carry on the business of electricians, electrical, mechanical, and metallurgical engineers, &c. The first subscribers (each with one share) are:—Lascelles Carr, Penarth, gentleman; Lewis Morgan, 100, Cathedral Road, Cardiff, solicitor; Henry T. Box, 42, Cathedral Road, Cardiff, solicitor; Patrick W. Carey, 52, Newport Road, Cardiff, gentleman; John W. Courtis, Bank Buildings, St. Mary's Street, Cardiff, stockbroker: Herbert A. Astbury, 55, Cathedral Road, Cardiff, bank manager; Harry Cousins, Western Mail Chambers, Cardiff, solicitor. The number of directors is not to be less than two nor more than five. The subscribers are to appoint the first; qualification, £100; remuneration, £100 per annum and a share in the profits divisible.

CITY NOTES.

Ernest F. Moy, Limited.

The report of the directors states that a profit of £489 18s. 8½d. has been earned during the year, and the directors recommend that this be dealt with as follows:—

10 per cent. dividend on 3,500 ordinary shares	£350	0	0
6 per cent. dividend on amounts paid up on preference shares (calculated from the dates the instalments were received) less income-tax	5	8	7
10 per cent. of profit to general reserve account	49	0	0
Income-tax on profit—£489 18s. 8½d.	16	6	8
And that the balance be carried forward to next year's accounts	69	3	5½
	£489	18	8½

The directors again propose to carry 10 per cent. of the profit to the general reserve account, which will bring up the reserve to £126 19s. 3d., and by carrying forward the balance of last year's profit, viz., £69 3s. 5½d., to commence this year with £244 17s. 2d. in hand. The directors are glad to be able to say that their expectations in regard to the business, as expressed in last year's report, have been more than fulfilled. During the past six months they have been compelled to refuse a large number of orders, and it has become absolutely necessary to raise further capital and to increase the size of the works, in order to cope with the increasing volume of business, and for the realisation of these objects an extraordinary general meeting has been called, *vide* the enclosed formal notice.

Elmore's German and Austro-Hungarian Metal Company, Limited.

The annual report states that the directors submit the accounts of this company and those of the "Metall" Company made up to December 31st. The accounts of the former company require little comment. The directors endeavoured to carry out the scheme of conversion of the debenture stock, but owing to the lack of support given by the shareholders, they were unable to do so. They were, however, able to issue £7,512 at par, redeemable at par, and £8,000 in addition was taken up by one shareholder at par, redeemable at 1 per cent. premium. The directors propose to postpone such conversion until June, 1900. With regard to the "Metall" Company's accounts, both sales and gross profits show a considerable increase as compared with the previous year. The directors of the "Metall" Company, having in mind the large cash requirements of the company for the purchase of copper, believe it would be, under ordinary circumstances, in the interests of the company not to pay a dividend, but, in view of the long period taken to reach the dividend-earning stage, they declared a dividend, after setting aside the legal reserve. The amount to be received by the Austrian Company from the "Metall" Company is M.150,000, or £7,500, from which has to be deducted the amount of the charges (£3,235 3s. 4d.) of the past year.

From the balance the directors recommend the payment of an interim dividend of 7½ per cent., or 3s. per share, free of tax, to the preference shareholders. The one-tenth of the net profit due to the ordinary shareholders being too small for division will be carried forward to their credit. In future the accounts of the "Metall" Company will not be published.

Guildford Electricity Supply Company.—A satisfactory report was presented at the annual meeting of the Electricity Supply Company. At the end of the first year there were 52 customers, and an output of 15,000 units. The statistics for the second year recently completed showed that the customers numbered 79, while the output was over 29,000 units. It was stated that the cost per unit to the company had fallen from 11d. to about 5½d. During the past year the price to customers in Guildford had been reduced from 8d. per unit, with varying discounts, to 6d. net. The directors reported a balance of profit on the revenue account, after an allowance of £150 for depreciation, of £149 odd. The report was adopted, and the retiring directors were re-elected.

Automatic Telephone Company, Limited.—The adjourned meeting of this company was held last week at Winchester House. Mr. Maurice E. Alexander occupied the chair, and after some remarks, a resolution was passed forthwith removing Mr. Margowski from the office of managing director. A proposal to amend the articles so as to alter the voting power in such manner as to prevent Mr. Margowski from outvoting the general body of shareholders was also agreed to. It was further decided that the committee should be authorised to take such steps as they might be advised are necessary to enforce the resolutions passed at the meeting.

The Indo-European Telegraph Company.—The directors, after adding £15,000 to the reserve fund, have determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31st, 1898, of 17s. 6d. per share, making with the interim dividend already paid 6 per cent., and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1st next.

Blackburn, Starling & Co., Limited.—The nominal capital of this company which takes over the business of Mr. Joseph Blackburn, contractor, electrical manufacturer, &c., of Nottingham, is £12,000 in £1 shares, and subscriptions have been privately invited for an issue of 8,500 shares at par. The offices of the company are at Gresham Works, Waterway Street, Nottingham.

Eastern Extension Telegraph.—Subject to confirmation by the shareholders, the directors have declared a dividend for the quarter ended December 31st last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1898. The dividend and bonus will be paid on 27th inst.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to recommend to the shareholders, subject to final audit of the accounts, a further dividend of 8d. per share, free of income-tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended December 31st, 1898.

Cuba Submarine Telegraph Company, Limited.—The directors recommend a dividend at the rate of 6 per cent. per annum and a bonus of 2s. per share on the ordinary shares, both income-tax free, for the half-year ended December 31st.

Stock Exchange Notice.—The Committee of the London Stock Exchange have granted a special settlement for the balance of the 6 per cent. preference shares of the British Insulated Wire Company, Limited, for April 12th.

Metropolitan Electric Supply Company.—Mr. James Carr Saunders has been appointed a director of this company.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending April 8th, 1899, were £602 10s. 10d.; aggregate to date, £3,123 4s. 7d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 7th, 1899, were £3,587 16s. 10d.; corresponding period, 1898, £2,810 9s. 0d.; increase, £777 7s. 10d.

The City and South London Railway Company.—The receipts for the week ending April 9th, 1899, were £976; week ending April 10th, 1898, £884; increase, £92; total receipts for half-year, 1899, £16,251; corresponding period, 1898, £15,826; increase, £425. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 8th, 1899, were £214 0s. 9d.; week ending April 9th, 1898, £119 2s. 7d.; increase, £94 18s. 2d. Total receipts to date, 1899, £2,109 19s. 9d.; corresponding period, 1898, £1,514 17s. 2d.; increase, £595 2s. 7d. Miles of track open week ending April 8th, 1899, 3; week ending April 9th, 1898, 3. Car miles run week ending April 8th, 1899, 4,207; week ending April 9th, 1898, 2,627. Number of cars, week ending April 8th, 1899, 11; week ending April 9th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, April 7th, 1899, were as follows:—D. U. T. Co., horse cars, £2,168 5s. 3d.; ditto, electric cars, £1,252 13s. 3d.; D. S. D. Co., electric cars, £934 2s. 10d.; total, £4,405 1s. 4d.; corresponding week last year—D. U. T. Co., horse cars, £2,467 5s. 8d.; ditto, electric cars, £406 1s. 0d.; D. S. D. Co., electric cars, £449 6s. 7d.; total, £3,322 13s. 3d.; increase, £1,082 8s. 1d.; aggregate to date, £45,955 19s. 2d.; ditto last year, £42,440 14s. 3d.; increase to date, £3,515 5s. 0d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending March 29th, 1899, were £312; total receipts to date, from June 29th, 1898, £10,712. Miles of track open, 6½. Car miles run, 6,544. Number of cars, 15.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 9th, 1899, amounted to £1,674; corresponding week last year, £1,539; increase, £135. 1898 includes Good Friday; 1899 includes Easter Monday.

The South Staffordshire Tramways Company.—The receipts for week ending April 7th, 1899, were £923 17s. 6d.; aggregate receipts for 14 weeks, £8,588 15s. 7d.; week ending April 8th, 1898, £609 6s. 9d.; aggregate receipts for 14 weeks, £8,081 10s. 1d.

STOCKS AND SHARES.

Wednesday Evening.

The four-cornered contest to decide which company shall have the honour (and profit) of supplying the City with electric light has been the main feature of interest to the market during the early part of this week. Some shyness in making prices, a slight disinclination to deal at all until matters assumed a more settled position—these are the two principal results of the week's work. Within the Stock Exchange there is a pretty general impression that the City of London Company will successfully maintain the monopoly, with whose loss it is threatened by the Charing Cross, the Smithfield, and the Metropolitan Companies. To back this view House men point to the special meeting of the Court of Common Council last Monday, when it seemed to be made clear that the Corporation is unfavourable to any change which might involve further difficulty when the time arrived for the company to be bought up by the City. The Board of Trade inquiry on Tuesday, when Sir Courtenay Boyle humorously described himself as being in the position of the lady who listened to three eloquent suitors for her daughter's hand, but who was unable to get her daughter to tell which of them she preferred, only served to make the market a little fidgety, with the result of a general decline. City of London fell ⅜ to 17¼, Charing Cross shed the same amount at 11, but recovered to 11¼. Other London shares remain about the same as when we last wrote. St. James's and Pall Mall Electric have risen 7s. 6d. to 17⅜, but County of London are unaffected by the "complaint" which its promoters lodged before the Select Committee of the House of Commons, and which was directed against the Board of Trade because the latter refused to grant the company powers to supply various suburban districts with electricity. South London are harder at 3⅜. The new issue of Chelsea 4½ per cent. debenture stock, in which a special settlement has just taken place, is quoted 114—116.

Among telegraph shares the Globe Telegraph Trust announces a quarterly dividend of 3s. per share on the ordinary capital, which is payable on April 29th, free of income-tax. The preference shareholders will receive 2s. 6d. at the same time. No change is noticeable in the price of the ordinary, which is steady at 13. Indo-European shares will receive a dividend of 17s. 6d. per share, plus a bonus of £1 per share, which makes 10 per cent. for the year, or the same as has been paid for 1896 and 1897. The price is nominally 58, but little or no market can be found.

A slightly better feeling has sprung up in the market for electric railway shares. Central London fully paid can now be sold at 10. City and South London stock, however, is still quoted at 68½, the market in this being also extremely limited.

The Midland Electric Corporation for Power Distribution, Limited, will probably make a place for itself in the London Stock Exchange, where at present it is almost unknown. The company has just issued a pamphlet outlining its objects, and adds an interesting account of its application to the Board of Trade for supplying electricity, &c., to the southern parts of Staffordshire. The ground is one which is barely served at all at the present time, and the company appears to possess a good scope for work. Other provincial descriptions are hardly mentioned.

Doulton preference shares are 26s. to 27s, and although the special settlement took place a week ago, they have not yet been admitted to the Official List. It is thought that when the trifling alteration in the company's papers is made which is required by the Stock Exchange Committee, the official quotations will quickly follow. Babcock & Wilcox are lower at 33½, but Glasgow is taking very little interest in the shares, and London looks to the North for inspiration in them. Electric Construction are quoted at 2½, and of Henley's there is a small seller about at 26.

In the tramway section there is a good deal of quiet strength. The Anglo-Argentine dividend of 2s. 3d. per share, making 3¾ per cent. for the year, as against 3 per cent. in 1897, is considered distinctly good, but the price is virtually the same at 4 7/16. British Electric Traction remain at about 19, and there is not much life in them.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, April 5th.	Closing Quotation, April 12th.	Business done during week ended April 12th, 1899. Highest.	Lowest
124,400*l*	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	...
905,560*l*	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	65 — 68	65 — 68	67½	66
3,047,220*l*	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	117½—118½	118 —119	119	118½
3,047,220*l*	Do. do. Deferred...	Stock	...	...	18s. %	14½— 15	14 — 14½	14⅝	14⅛
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15¾— 16¼xd	15¾— 16¼	16⅛	15¾
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	185 —195 xd	185 —195	190	188
1,332,523*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106 xd	104 —106	105¾	105
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	18 — 19	18½— 19½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5 xd	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11 xd	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109%	106 —109%	...	...
60,710*l*	Direct United States Cable	20	3 %	3¼ %	...	12¼— 12¾xd	12 — 12½	12½	12 1/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	103 —106	103 —106	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½ %	7 %	...	179 —184	177 —182	180	176½
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	102 —105	102 —105	104½	102
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	99 —102	99 —102	...	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	125 —129	125 —129	125	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	18 — 18½	18 — 18½	18¼	18⅛
16,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	125 —129	125 —129	...	...
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	...	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5½ %	12¾— 13¼	12¾— 13¼	13⅛	12¾
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	17⅛	17 1/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30 — 31	30 — 31	30⅝	...
97,800	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	57 — 60	57 — 60	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
490,000	National Telephone, 1 to 490,000	5	5½ %	6 %	6 %	4½— 5	4½— 5	4⅝	4½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	12	11½
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	12⅜	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5¼	4¾— 5¼	4 15/16	4¾
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —101	99 —101	101	99
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1	⅞— 1	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	7 — 8	7⅞	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	141	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	...	...
151,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000*l*	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	½	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	107¾	...
88,321	West India and Panama Telegraph	10	1 %	¾%	...	2 — 2¼	2 — 2¼	2 3/16	2⅛
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10½— 11	10¾— 11¼	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100*l*	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	10½— 11½	11⅜	11¼
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	7½— 8½	7½— 8½	8	7 15/16
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	17 — 18	16½— 17½	18	16½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15⅛	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	*nil*	11 — 12	11 — 12	11⅝	11 1/16
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15 xd	14 — 15	14½	14
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5¼— 5⅜	5¼— 5⅜	5 7/16	...
19,661	House-to-House Electric Light Supply, Ord., 101 to 19,661	5	...	4 %	6 %	8½— 9½	8½— 9½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	9 11/16	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 4	3 15/16	...
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 7	6⅝	6 9/16
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	105 —107	105 —107	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	17 — 18 xd	17 — 18	17⅜	17¼
22,500	Do. Nos. 62,501 to 85,000, £7 paid ...	10	...	...	...	13 — 14 xd	13 — 14	13¾	...
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	117 —120	117 —120	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16½— 17½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	17 — 18	17½— 18½	18	17⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3½— 3⅝	3½— 3½	3⅝	3½
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15½— 16½	15 — 16	16	15½

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation April 5th.	Closing Quotation April 12th.	Business done during week ended April 12th, 1899. Highest	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	3 — 3½	3 — 3½	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100 xd	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	19½— 20 xd	18¾— 19¼	19⅜	18 15/16
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13¾— 14¼	13¾— 14¼	14¼	13¾
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	125 —128 xd	126 —129	127	126¾
90,000	Brush Elec'l. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2 1/16	1 15/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	2 5/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½ %	...	12½— 13½	12½— 13½	13 1/16	13
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10⅛	9⅜— 10⅛	10⅛	10
178,303	Do. do. do. £8 paid	10	...	...	...	7¾— 8¼	7¾— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3½— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4¾	4¼— 4¾	...	...
630,000*l*	City and South London Railway	Stock	1 9/16 %	1⅞ %	2⅛ %	68 — 70	68 — 70	69	68¼
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¼— 3⅜	3¼— 3⅜	3⅝	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 — 101	98 —101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5⅛ %	6 %	...	2 — 2⅛	2 — 2⅛	2⅜	2⅛
17,139	Do. do. do. "A" Shares, 01—017,139	5	5⅛ %	6 %	...	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	97 — 99	97¾	97½
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	3⅝	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	½— ¾	½— ¾	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	25½— 26½	25½— 26½	26½	25¾
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	18½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22 3/16	22⅛
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	102¼	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅛ %	3½ %	3½ %	10 — 10⅛	10 1/16—10 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅝— 14⅞	14⅝— 14⅞	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	35 — 39	39½	35½
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¾— 10¼	9¾— 10¼	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼ xd	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112	109 —112	111	109½

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.
British Aluminium, Ordinary, 10½—11; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.

* From Birmingham Share List.

National Electric Free Wiring, 10s. paid, ⅜—½.
Smithfield Market Electric, 3⅛—4½.
*T. Parker, £10 (fully paid), 16.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, April 12th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a ,, Nitric .. .. .. per cwt.	22/-	22/-	..
a ,, Oxalic .. .. .. per cwt.	32/-	32/-	..
a ,, Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammonia, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a ,, ,, (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. per gal.	7/-	7/-	..
a ,, (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£25 10	£25 10	..
a Lead, Nitrate .. .. .. per ton	£29 10	£29 10	..
a ,, White Sugar .. .. per ton	£30 10	£30 10	..
a ,, Peroxide .. .. .. per ton	£37 10	£37 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	8¾d.	8¾d.	..
a ,, Caustic (75/80 %) .. per ton	£24	£24	..
a ,, Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a ,, Recovered .. .. per ton	£5 15	£5 15	..
a ,, Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a ,, Crystals .. .. .. per ton	£3	£3	..
a ,, Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b ,, Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£65 to £130	£65 to £130	..
c Brass (rolled metal 2" to 12") basis per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed) .. .. per lb.	10d.	10d.	..
,, Wire, basis .. .. per lb.	8d.	8d.	..

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f ,, Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£80	£80	..
g ,, Wire (basis price) .. per lb.	9½d.	9½d.	..
g ,, Sheet .. .. .. per ton	£80	£80	..
g ,, Rod .. .. .. per ton	£80	£80	..
h German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. .. per lb.	4/3½	4/4	¼d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i ,, Pig (Cleveland warrants) per ton	47/11½	48/9	9½d. dec.
i ,, Forgings, according to size per ton	From £11	From £11	..
i ,, Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i ,, Wire galvanised No. 8 .. per ton	£9 7 6	£9 5	2/6 inc.
g Lead, English Ingot .. .. per ton	£14 12 6	£14 12 6	..
g ,, ,, Sheet .. .. per ton	£15 10	£15 10	..
l Mica (uncut slabs 6" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/- to 1/4	1/- to 1/4	..
p ,, rolled bars & rods per lb.	1/- to 1/4	1/- to 1/4	..
p ,, r'l'd strip & sheet per lb.	From 1/2	From 1/2	..
o Platinum .. .. per oz.	£3 10	£3 10	..
p Silicium Bronze Wire .. .. per lb.	10d. to 1/1	10d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£115	..
g ,, foil .. .. per lb.	1/6	1/6	..
n ,, wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7½d.	7½d.	..
j ,, Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j ,, Hemp, 8 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j ,, ,, Russian, 10 lbs. per lb.	4½d.	4½d.	..
j ,, Jute, 180 lbs. rove .. per ton	£12	£12	..
j ,, Manila, 24 thread .. per ton	£34 10	£35 10	£1 dec.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31	£31	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

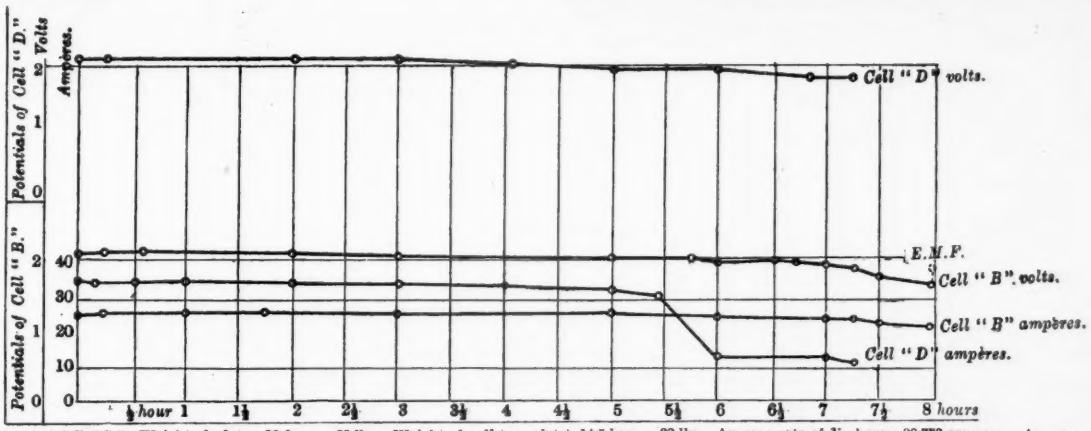
Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

THE VICTORIA ACCUMULATOR.

The following report on the above battery, by M. Paul Dupuy, consulting engineer, of Paris (dated March 17th, 1899), is handed to us by the Eclipse Brass and Copper Company, Halifax:—

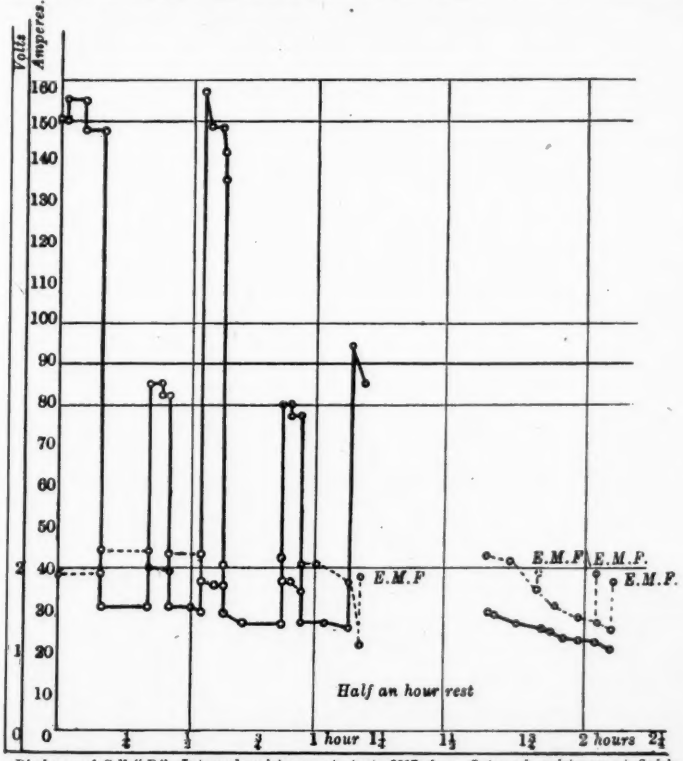
"In October, 1898, I received two detailed reports made in January last by Mr. Sappey.


Potentials of Cell "D." Volts
Amperes.
Cell "D" volts.
E.M.F.
Cell "B" volts.
Cell "B" amperes.
Cell "D" amperes.
Potentials of Cell "B."
½ hour 1 1½ 2 2½ 3 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 hours

Discharge of Cell "D."—Weight of plates, 10 kgs. = 22 lbs. Weight of cell (complete), 14·5 kgs. = 32 lbs. Average rate of discharge, 29·773 amperes. Average rate of discharge, 55·6 watt-hours. Average capacity, 212 ampere-hours. Average capacity, 409·16 watt-hours. Average per kg. of plates, 40·91 watt-hours.
Discharge of Cell "B."—Weight of plates, 10 kgs. = 22 lbs. Weight of cell complete, 14·5 kgs. = 32 lbs. Average rate of discharge, 24·18 amperes. Average rate of discharge, 42·36 watts. Average capacity, 193·45 ampere-hours. Average capacity, 386·9 watt-hours, Average per kg. of plate, 38·69 watt-hours. Average potential, 2 volts,

"In examining the figures of this report, I came to the conclusion that the accumulator showed considerable progress over other types in present use. Owing to the death of Mr. Sappey, I have been requested to continue the experiments in Paris. I was handed the report of Mr. C. E. Spagnoletti, late president of the Institution of Electrical Engineers, and dated March, 1897; also the report of Mr. G. J. Gibbs, electrical engineer to the Power Transmission and Traction Syndicate, Bradford, whose figures correspond absolutely with those made by Mr. Sappey.

"Without entering into details (the examination of which will follow), we may say that the figures of the different tests corroborate



Discharge of Cell "B."—Internal resistance at start, ·0017 ohm. Internal resistance at finish, ·043 ohm. Average ampere-hours, 78·5. Average watt-hours, 143·25. Weight of plates, 10 kgs. Weight of cell complete, 32 lbs. = 14·5 kgs. Capacity per kg. of plate, 14½ watt-hours.

themselves in every respect. In order to be thoroughly satisfied and to be in a position to say that these figures are correct, I notified that I would make a personal trial. I also stipulated that the experiments and tests should be carried out in Paris with instruments that are calibrated by us. These tests have been made under my personal supervision in the School of Physics and Industrial Chemistry in the City of Paris by Mr. Gasnier, chief of the electrical laboratory of Mr. Hospitalier, with the results afore-mentioned. Report dated March 11th, 1898.

"In examining the results arrived at by us, we find that the figures exactly coincide with those produced from the English tests. I found that at the rate of 40 amperes discharge the element had a total capacity of 168 amperes. The element, D, at the average rate of 53·5 amperes, has given 13·6 ampere-hours per kilo. of element.

"We considered that the figures should be given on the total weight of the element, because it is the only factor for traction purposes. The useful energy in watt-hours per kilo. of element is 25 watt-hours.

"We have remarked that in every test made the efficiency of the Victoria accumulator diminishes very little in proportion with an increase of the rate of discharge.

"As example:—At the rate of 1·36 amperes per kilo. of energy it is 77 per cent. At the rate of 5·25 amperes per kilo. it is 76 per cent. At the rate of 8·15 it is 50 per cent.

"To give a clear idea of the value of the Victoria accumulator, we have, with Mr. Gasnier, made a comparison of it with the Fulmen accumulator, the data of which we obtained from the official report on the trial of the electric vehicles made by Mr. Forestier, of the Automobile Club of France.

Discharge in five hours.	Fulmen.	Victoria.
Normal rate in amperes per square decimetre of positive surface ...	1	1·41
Normal rate in amperes per kilo. of element	2·7	2·68
Average useful potential per element in volts	1·9	1·96
Normal specific energy in watts per kilo. of cell...	5·1	5·3
Specific capacity in ampere-hours per kilo. of cell	13	13·7
Specific energy in watt-hours per kilo. of cell...	25	26·6
Total weight per kilowatt	200	197
" " hour ...	40	39·3
" " H.P.-hour	29·4	28·8
Thickness of plates in millimetres ...	4	7·5 to 8
Total positive surface per kilo. in square decimetres	2·81	1·9
Volume in cubic decimetres per kilo-watt-hour	18·4	15·8

"It will be seen with the plates of double thickness and the total volume 14 per cent. less, the Victoria accumulator gives better results than the Fulmen, which is actually considered to be the lightest and the most popular accumulator for traction.

"This shows that with the same weight the *mechanical strength* of the Victoria accumulator *is much greater, the cost of maintenance is less, and the life considerably increased.*

"These are the principal factors which constitute the present difficulties in electric traction, and the Victoria accumulator is certainly a real progress on all that have preceded it.

"How is this superiority obtained?

"The reply is simple. Allowing that the Victoria grid is most ingeniously designed and has some remarkable points in it, we must look for the reason of this superiority to the composition of the paste.

"This point of view is in agreement with that of Prof. G. de Knorre, of the Imperial Polytechnical School of Charlottenburg, Berlin, and we give in detail the conclusion of the report made by this eminent Doctor of Science on the Victoria accumulator.

"'This invention appears to me to have considerable technical

value. My personal tests prove to me that the formation of the plates, pasted with this new active material is done very easily. The new process could be considered much superior by reason of the great power of reaction of the carbides contained in this substance and added to the active material. I consider this vastly superior to other processes employed up to the present, where coke and carbon are mixed with the salts of lead.'

"This, therefore, is the real reason of superiority of this new accumulator. We may add in passing that we have noted the quick manner in which the paste hardens, and the tenacious manner in which it adheres to the grid, which is a consideration not to be overlooked, owing to its important bearing on the long life of the accumulator.

"We have also made comparative tests at the tramway works of the Department de la Seine, and the figures so obtained are infinitely superior to those shown by the Laurent-Cely accumulator, which is in practical use at these works.

"The capacity of the latter is 8 ampere-hours against 13½ obtained from the Victoria accumulator.

"Conclusion.—The results of the Victoria accumulator are obtained from different reports and prove beyond question that the Victoria accumulator is the best yet produced, and I am convinced that the success of this battery can be considered certain."

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

By PHILIP DAWSON.

(*Concluded from page* 572.)

There are, therefore, three distinct types of elevated railway equipment, the steam locomotive using 10 to 15 per cent. of the train weight for traction under heavy traffic conditions, the electric locomotive using 30 to 35 per cent., and the multiple unit system using any amount desired up to 60 per cent. of the train weight.

The transportation expenses of the South Side Elevated Railway in Chicago for July, August, and September, 1897, when steam locomotives were employed, were 2·8 cents per car mile, while in the same months of 1898 they were 1·9 cents per car mile, or a saving of nearly 0·9 cents, or about 33 per cent.

Metropolitan District, London.

Average speed in miles per hour	13½
Maximum " "	27
Minimum time between consecutive trains ...	2 minutes.
Average " " " ...	3½ to 4 minutes.
Total weight of train	161 tons.
Average carrying capacity	450 passengers.
Weight of locomotive	47 tons.
Average distance between stations	2,600 feet.
Time required in seconds to reach 25 miles an hour, starting from a standstill	30 seconds.

The figures in the above table show at once the great advantage to be gained by electric traction, by means of which speed of 25 miles an hour could be obtained in 10 seconds, and by simple calculation it is easy to ascertain that this would greatly increase the average speed, and therefore decrease the time necessary to do the distance.

The characteristic difference between the acceleration curve of a train hauled by a steam locomotive and one driven electrically is that, whereas the acceleration where steam is used as motive power increases at first, slowly following a curve which is nearly tangent to the horizontal or time axis, the acceleration curve in the case of electric propulsion is represented by a straight line rising very rapidly, and forming a very small angle with a vertical axis.

It may be interesting to mention a few details regarding the two large power stations which are now being equipped in New York, and which will operate the two large tramway systems of that city, namely, the Metropolitan and the Third Avenue. The Metropolitan station is now under construction, and will contain 11 direct-connected sets, each of 3,500 kilowatts, room for extension being allowed, and a capacity having been foreseen of nearly double that amount. The following gives the particulars of the General Electric Company's dynamos which will be used.

The machine will have a frequency of 25 cycles per second, at 6,600 volts. It will have 40 poles, and will run a speed of 75 revolutions per minute. It will be of the stationary armature type, the core being built up of laminations ·014 inch thick. Each lamination has two dove-tail projections which fit in corresponding slots in a heavy cast-iron spider. Spaces are left between the laminations at intervals through which currents of air are driven by the rotating field and circulating by intimate contact with core and windings. The armature winding consists of form-wound coils placed in slots in the core and retained by wooden wedges, the edges of which fit into recesses in the teeth. The field frame consists of a cast-steel ring supported upon a cast-iron spider; to this are bolted laminated core of sheet iron, the pole pieces of which project over and support the copper field windings. The field winding consists of copper strip wound on edge with paper insulation between turns. The insulation is such as to stand a test of 4,000 volts alternating between the winding and the core. The exciting E.M.F. is 125 volts. The collecting rings are of copper, and carbon brushes are used. The armature winding is tested to 12,000 volts alternating. The temperature rise of the machine, after 10 hours' run at full load, is well under 40° C. The efficiencies are as follows:—

	Per cent.		Per cent.
1¼ load	90	½ load	92·5
Full load...	95·5	¼ load	88
¾ load	95	Inherent regulation ...	9

The steam engines which drive these dynamos are cross compound Allis vertical engines, 46 inches high and 86 inches low pressure cylinders, and 60 inches stroke. They will develop 4,500 indicated horse-power at the rated economical load, and will be able to work continuously at 6,000 horse-power if required, and for a short space of time they are to be able to work at 7,000 horse-power. The crank shaft is of solid steel, bored and forged, with a hole 16 inches diameter the entire length, and it is 37 inches in diameter where the wheel and armature are located. The diameter of the shaft in the bearings is 34 inches, and the length of the bearings 60 inches. The fly-wheel will have cast-steel centres, and the rim will be built up of steel plates riveted together. The rim will weigh 225,000 lbs., and the engine itself, complete, about 600 tons, and it is believed that as good results as 12½ lbs. of steam per indicated horse-power will be easily obtained. There will be several sub-stations, in which will be located step-down transformers of 300 kilowatts each, which will lower the voltage from 6,600 volts to 350 volts. At this pressure the current will enter rotary converters of 900 kilowatts each, and will be delivered in the shape of a continuous current of 500 volts to the tramway system.

This company operates some 250 miles of tracks, and carries, approximately, 250 million passengers every year.

The Third Avenue Road is now engaged in equipping all existing horse and cable lines with electric traction, and for this purpose has just given out a contract for a power station which will eventually contain 16 3,000-kilowatt generators. The generators will be very similar to those described above, and are being built by the Westinghouse Company, who are the sole contractors for the whole work. The engines will be marine type, vertical, and are being built by the Westinghouse Machine Company. Sub-stations with rotary transferers will be used, as in the case of the Metropolitan system.

To give an idea of what may be done as regards power transmission the following few figures may be useful. The first attempts at this class of work were made during the Frankfort Exhibition of 1891, 300 horse-power being satisfactorily transmitted a distance of 106 miles with a pressure of 30,000 volts. Since that time electrical power transmission has largely increased, and the results obtained have been very satisfactory, 4,000 horse-power at the present moment are regularly transmitted a distance of 85 miles to the city of Sacramento, California, at a pressure of 30,000 volts, where they are transformed into low pressure three-phase and continuous current for lighting, power, and traction purposes. At Telluride, Utah, 1,000 horse-power are transmitted 55 miles at a pressure of 40,000 volts; 4,500 horse-power are transmitted a distance of 40 miles to Salt Lake City at a pressure of 15,000 volts; 1,400 horse-power are being transmitted 35 miles to Fresno, California, at a pressure of 11,000 volts; 2,000 horse-power are being transmitted 30 miles to West Kootenay, British Columbia, at a pressure of 20,000 volts; 10,000 horse-power are being transmitted from Niagara to Buffalo, a distance of 22 miles, at a pressure of 10,000 volts. All the plants are working and giving satisfaction, and have nothing experimental about them, and there are hundreds more such.

In the designing and carrying out of a large system, there are three points which are frequently overlooked, and which may cause a disastrous failure. These are good and adequate bonding; thoroughly good insulation, both mechanically and electrically; and trucks suited for the work for which they are intended.

As regards the bonding, the bonds used should be flexible, but, at the same time, should contain no solder or brazed joint, and they should be expanded against the side of holes drilled in the web or foot of the rail, and held in place by pins. Bonds of this description, when properly applied, can be absolutely relied upon, the contact resistance of the bond with the rail not being greater than the resistance of the solid bond.

With regard to the third rail insulators, very good results are obtained by using insulating bolts screwed into base plates which are fixed to the sleepers, cast-iron chairs being fixed to the head of the bolts to hold the rails.

* Society of Arts, March 22nd.

DISCUSSION.

The Chairman (Prof. C. A. Carus-Wilson) said they were all much indebted to Mr. Dawson, who was well known as one of the leaders in the introduction of electric railways into this country, for giving them so much interesting information on a subject which was now of universal interest, and he hoped for a good discussion. The author's

remarks on the subject of the drop in the feeders, and the different methods of overcoming this difficulty, were of great interest, and he might say that this question was of more importance to us than to American engineers, since in this country, fortunately or otherwise, we had a Board of Trade, and had not such a free hand as they had in America. One of the methods suggested was the use of the negative booster, which was practically a series generator with the fields in series with the feeder, so that the generator added just as many volts as was necessary to compensate for the drop in the feeder. Mr. Dawson had dismissed rather peremptorily the three-wire system, about which there was a good deal of difference of opinion. He understood that this system was going to be tried on the extension of the City and South London Railway, and he trusted that it would not prove a failure in this case. He hoped there were some present who would take up the cudgels on behalf of polyphase motors, as he did not himself feel disposed to acknowledge that they were out of the question for railways running over short distances, where rapid acceleration was required. In considering the question of the amount of energy required for operating trains under the circumstances dealt with in the paper, the question of the efficiency curves of the motors was really not of much importance, because the speed of the motor was continually changing, and the value of its efficiency at a certain speed did not go for very much. The real question was, what was the least amount of energy in watt-hours per ton-mile required to cover the given distance? On the Central London Railway inclines were being used outside the stations, so that the engines might have the benefit of the incline during the process of starting. Calculation showed that the value of these grades was greatest when they acted during the first few seconds, but this was practically impossible, and he was inclined to think that rather too much was made of the advantage of these inclines. He understood that a difficulty had occurred in connection with the grades on the Waterloo and City line, which was virtually a switch-back railway. It seemed that the equipment was not sufficiently powerful to haul the train up the steepest grades backwards, being designed simply with a view to the trains running in one direction only. In any railway where grades were used, the equipment should be able to haul the trains in either direction in case of emergency, such as might occur when a single line had to do duty for two. Mr. Dawson thought that steam locomotives were unable to compete with electric motors in rapid acceleration; he hoped there were some steam engineers present who would take up that question. Steam engineers did not seem to realise the importance of designing locomotives for short runs with rapid acceleration. It might be quite correct that such a curve as had been shown was a fair average sample of what a steam locomotive could do at present; but he thought that if steam engineers set to work to improve the design, they might get a curve more nearly approximating to that of the electric locomotive. The process going on during the time that a steam locomotive was getting up speed was one about which very little was known, and very few experiments had been made with a view of ascertaining what it was which prevented the rapid acceleration which was obtained in an electro-motor. The figures given with regard to the South Side Elevated Railway, Chicago, were of importance. He assumed that under the head of transportation were included the cost of the motor men and conductors, and it was interesting to hear that on that railway, when steam was employed, the cost was 2·8 cents per car mile, and that when electricity was substituted it fell to 1·9 cents. In that connection Mr. Sprague's method of multiple unit control had been referred to, and he should be glad to hear more particulars about it, as it appeared to effect a great reduction in the cost of operating a train. He understood that the method consisted in having a single motor man located at one part of the train who, by a system of switches, operated a number of motors, which might be placed on every axle; so that one man could do the work of many. There was also the advantage of having a motor on each axle, which greatly increased the adhesion effect. He was not behind anyone in his appreciation of what the Americans had done in connection with electric railways, but he was sorry to see so many large contracts go across the water—especially that for the Central London Railway. The advantage to be looked for from papers such as this, was that Englishmen might be so well posted in what Americans were doing that they would be able to beat them on their own ground.

Mr. Leon Gaster said trains had been working for some time in Switzerland on the three-phase system. The circuit was conveyed to the three-phase motor direct without rotatory converters. The London Central Railway has made use of the polyphase current, but uses rotary converters, which, according to Mr. Parshall's design, ought to work with very high efficiency; but there were special facilities there, the electricity being generated by water-power and conveyed a good distance. The question of bonding was very important, as it prevented a great drop of voltage, but it was a question which was the best method, and in many respects he thought that of electric welding stood first. England was very much behind with regard to electric traction, but he thought the chief reason was that they had so much money invested in steam, which had been thoroughly tested and proved successful, and they did not like the change until they were perfectly sure that they would get a good return for their money. Positive figures, such as had been given in the paper, showing the saving effected by the introduction of electricity, would have a very important effect on the public mind.

Mr. E. Kilburn Scott thought they ought to have a clear understanding of what was meant by a short distance; was it such a distance as that between the stations on the Metropolitan or District Railways? The railways which had been referred to in Switzerland were working very well indeed, and he considered the traffic was going to be dealt with entirely by the three-phase current. The railways, of which photographs had been shown, were not in many cases lines in which the stations were at all close together; those in California, for instance, were a fair distance apart. There they started with a three-phase current, and they might as well go through with it, and put three-phase motors on the cars, and do away with rotary converters. He suggested that we should not be in too great a hurry to copy the American overhead system of distributing, or we might find that by the time we had introduced it they had discarded it in favour of the conduit system, which was already being introduced in the Washington and Third Avenue lines. It would also be a pity not to give the three-phase system a trial. He believed it would accelerate quite as quickly as a continuous current; and that, for such distances as were required in London, it would be quite as economical as a combination or the three-phase and continuous.

Sir H. Trueman Wood said one important conclusion which might be drawn from this paper by the general public was that the time had come for insisting on electric traction on the metropolitan railways. He was in Chicago when the South Side Elevated Railway was constructed—not six years ago. It was to run from Chicago to Jackson Park, and it was not ready until the World's Fair had been open for some time. It was then worked by steam; it was a new line, furnished with new plant. Yet the owners had found it to their advantage to give up all the steam plant they had and work it by electricity. It was an overhead line, and he did not suppose that it mattered two pins to the passengers whether they were drawn by steam or electricity; but that was not the case in London. Here we were taken through tunnels in an atmosphere which nearly asphyxiated one, and the public had a right to demand that if other means of traction could be substituted for steam, the alteration should be made. It might be said that the Chicago line was a small one, and therefore the abandonment of the plant did not not so much matter, but then they might refer to the New York Elevated Railway, which had been running a great many years, and that also had found it worth while to abandon the old plant and substitute new. Such examples ought to make Englishmen ashamed of themselves. He wished Mr. Dawson had included in his illustrations one or two of the common American electric tramways which ran from the half-finished towns of the west or south into the backwoods. Before any roads were made a line was laid down running into the country, and rapidly drew around it a number of outlying suburban houses. A year or two ago, when he was in Tampa, which at that time was being developed as a watering place, he found that there was not a road into the surrounding country on which a human being could walk, or a horse or vehicle travel; but there were several excellently equipped electric tramlines on which you could go a mile or two into the country, and walk back through the woods.

Mr. Tremlett Carter said he should not like it to be supposed that in America the trolley system was being given up for the conduit system to any appreciable extent, or that the former system was not perfectly successful. The conduit was only adopted for special reasons, as in Washington, where it was obligatory; but directly the lines got outside the district of Columbia the trolley system was used, notwithstanding the delay which was incurred in transferring the cars from one system to the other. Some of the local authorities insisted on the conduit system, but there was no failure of the trolley system.

Mr. James Swinburne said the growth of electric traction was so rapid that it would be a kindness to engineers if Mr. Dawson would give a lecture every few months showing how far it had gone. In England they were apt to take a sort of parochial view, and neglect what was being done in other countries, so much so that those who did know what was going on abroad were sometimes rather ashamed of their own country. We were kept back in England by a kind of conservatism, which objected to anything new, and also by too much officialism. But, after all, that kind of pigheadedness which kept us back at the beginning had one good result, that when we did make a start we generally did our work very well, better often than it was done in other countries; and an industry which had got past the youthful age was often carried on better in England even than in America. He did not wish to say anything against the Americans, for whom all who knew them had an immense respect, but they had rather a way of putting down a station and making it go somehow, and then pulling it all up and putting down a better one. We could not do that in England; if we made a mistake once, it practically gagged the industry at the start, and in some respects it was better to go slowly. One of the most important questions with regard to large power distribution for electric railways was the use of the polyphase system. The polyphase motor on a car had two drawbacks—first, that it wanted three contacts instead of two, and the second was said to be that you could not get enough torque at starting. He could not see why this should be, and had never got a satisfactory answer to the question. With a direct current, if you wanted to get a large torque, you gave it as large an armature current as you could, and as large field excitation as possible; you increased both elements. But a polyphase motor would do that equally well. He did not care which was the armature and which was the field; you had the two elements in the polyphase. One was connected to the line and got the alternating current, and you could increase the field, or the induction, by reducing the number of turns, and in that way you got one element. The other element had an induced current in it, and that depended simply on what resistance you put in the circuit to start with. There was no inherent reason why you should not multiply the two effects in the polyphase as much as in the direct current motor. He could never find out what the real difficulty was from that point of view. Another subject of some importance was that of electrolysis. When electric traction was first proposed in England everybody was against it, and the first objection made was to overhead wires, which obscured the blue light of heaven and obstructed the traffic, and so on. That was now got over, because when people found that this mode of traction was adopted in all the most beautiful towns of the Continent, there was no æsthetic reason why it should not be employed on the Underground Railway or along the Old Kent Road. Then a new

danger was discovered in electrolysis, and that was more serious, because even engineers did not know much about it. The bold assumption that it could not take place unless you had more than 1½ volts was nonsense, the least difference of pressure was enough to start electrolysis when you had metals which were greedy of oxygen, such as iron. The negative booster seemed to be a solution, but on a large scale it might be difficult to work. This was a matter in which they had gone ahead immensely in America, and when Mr. Dawson gave his next periodical lecture he hoped he would tell them how the gas and water pipes were getting on, if there were any left at all. Surface-contact systems did not get over this difficulty at all; they only got over the imaginary difficulty of the trolley. There were three small points mentioned which seemed to be looked upon as American—one, the feeder booster, which was proposed first by Major Cardew; another, the compounding up of dynamos, which was proposed by Dr. Hopkinson in his three-wire patent of 1882, and was used in this country by all dynamo makers since 1883 or 1884. He was not sure that Edison did not invent the same thing in 1882, many of the patents of Edison about that time were almost the same as some of Hopkinson, Marcel Deprez, and other European inventors. Putting a motor on each wheel was also an old English idea, but it never came into use because we did not have any motors. With regard to steam locomotives, the difficulty of acceleration might be put very easily. In an electric motor you could always, by increasing the two elements, get a great torque, but you could not get a large initial torque in a locomotive without having the whole engine large, because you could not overwork the engine. You could only fill the cylinder with steam, and if you had a large cylinder which was full of steam to start with, the result was, when you were running rapidly, you were expanding too much. The question of starting torque was quite understood by locomotive engineers. The District engines, for instance, were specially designed for their work; they were not designed for fast running, and would not draw an express train. Mr. Dawson said that in the United States they were giving up high speed engines, and using Corliss, which were always comparatively slow, even the American ones, which were the fastest. But he should like to know what the high-speed engines were which were replaced—were they up to the standard of the English high-speed engines? He could not see any advantage in using a Corliss engine for an electric railway. It had been said that the American high-speed engines were really tests of how much steam would go through a 3-inch pipe, and others, again, said that definition was incorrect, that they were really a small obstruction to a 3-inch pipe.

Mr. W. M. Mordey said the discussion seemed to turn more on the future than the present, perhaps because that was more interesting. With regard to polyphase working, they might take comfort from the fact that, if there was any future for it, they were starting in one important case in London with polyphase generators, so that if found possible, later on, to carry the alternate current direct to the motors on the cars, it could be done with a comparatively slight alteration. The generating plant and mains would not require to be altered. This question of alternate current traction was being worked out in Switzerland, where so many good things in alternating work had been done, and they were all watching with great interest the experiments being made by Mr. Brown on the Jungfrau Railway and elsewhere. As far as he could gather, the future of polyphase traction work was going to be very great. At any rate, there did not seem to be anything like the difficulty about starting that was supposed; and even if there were some difficulties, it must be remembered that there was an inherent economy in alternating current machinery in one important respect, which might compensate for some drawbacks. For starting, whichever system was used, they wanted a large current but a small E.M.F. In direct current working, the starting was done under conditions of great wastefulness, because large resistances had to be inserted in the motor circuit. With an alternating current they could put in a back E.M.F., which was not wasteful. They must not forget that they owed to America practically the present electric tramway system. He had seen many of the tramway systems in America, and in Europe as far as Buda-Pesth, and he must say that he was astounded at the way in which the Americans had developed the system, often in the face of great difficulties, and when there was not really sufficient knowledge to enable them to deal adequately with the problems. They did the best they could at the moment, and were not afraid to discard plant when they had developed anything better. America had been described as the laboratory of the world, and it was certainly the electrical laboratory. While we are glad to benefit by all this experience, we must not be misled into supposing that finality had been reached, or that the present American practice is necessarily best for English conditions. England, as Mr. Swinburne had said, was slow to begin, and that was why she was the banker of the world. They must all thank Mr. Dawson for having given them so much information on what is now being done.

Mr. Dawson, in reply, said the first time the negative booster was tried in England was at Bristol. They found there that when they had a fall of potential of 7 volts, by introducing the booster they could reduce that fall by four, and bring it down to three, well within the Board of Trade limits. It was quite true there might be a difficulty in using boosters on a large system, and that was why he said that in stations of above 4,000 kilowatts the polyphase system became financially the only possible thing; otherwise they would practically have to make the street into a copper mine. The question of the three-wire system was one they had been fighting over for a long time, and he did nor suppose they would agree now. It would be interesting to see what were the results on the South London extension; at present it had not proved so satisfactory on lighter train lines as was expected, and for that reason, as well as on theoretical grounds, he did not think it would be satisfactory. If he proved to be wrong, he should be glad to acknowledge it. With regard to what was to be considered a short distance, he meant such distances as between the stations on the District Railway. The experiments hitherto made with three-phase motors, for which they were much indebted to the Swiss, and especially to Mr. Brown, had been on lines running longer distances, and there the power practically cost nothing. With regard to the multiple-control system, there was very little information yet given as regards the financial results, but it seemed to be working very satisfactorily, and had been taken up by several large American companies. It would be very useful in cases like the Metropolitan District, where there were branches or junctions, because the train could be divided, and one part go in one direction and the other in another. He should like to see the polyphase motor system tried in England, but the question was, who would run the risk? They knew that the continuous current was economical for a certain class of work, and it could be guaranteed, but they were not so sure whether a polyphase motor would do it. The question of electric welding had been raised, but it had been abandoned in favour of cast welding, chiefly on account of the great expense attending it. It required a power of about 200 kilowatts to make a weld. With reference to the conduit system, he might say that he did not intend to raise the question of tramway at all. He was dealing rather with suburban and metropolitan railways. The conduit system had been carefully examined by hard-headed men of business and skilful engineers, and they came to the conclusion that practically there were a very few streets, in a very few towns, where conduits would be justified, the chief reason being the enormous cost, which would be much greater in England, probably, than America. Here engineers were not allowed to put a town in a state of siege; in Brussels, when the conduits were being constructed, four or five miles of the finest streets were absolutely closed to carriage traffic, and almost to that of foot passengers. He welcomed Sir Henry Wood's remarks with reference to the District Railway, which he had to use daily, and knew what the atmosphere was like. If electricity were used, it would be much more comfortable, and it would not only cost less to work the line, but many more people would travel on it. The object of the paper was to bring before the public what was being done in other countries. He had been sometimes accused of trying to introduce American goods and machinery in place of English, but his desire was just the opposite. If we did not know what other people were doing, and why other people's machinery was better or was supposed to be better than our own, we should never be able to compete with them. The result of our conservatism had simply been that we had waited until Americans had come over here and found that we were practically not in a position to do the work which was wanted at a reasonable price, and they stepped in and got the business. Had we realised seven years ago what a success electric traction was going to become, we should have heard very little of American competition. The question of electrolysis was a difficult one, but so far there had not been much complaint in England. One reason why our lines were safer than the American was that ours were laid on concrete, which had a very appreciable resistance; moreover, our tracks were very well bonded, and he did not think there would be much trouble. There was only one safeguard—good bonding and heavy returns. That was why, when you got to long-distance transmissions, you must use polyphase machinery. Otherwise, the amount of copper would be too great.

The Chairman then proposed a hearty vote of thanks to Mr. Dawson, which was carried unanimously.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Hissing of the Electric Arc. By Mrs. Ayrton. (Read on March 23rd, 1899.)

(*Continued from page* 568.)

During the course of his 1899 experiments, Luggin* observed that the arc hissed when the crater filled the whole of the end of the positive carbon. He was thus the first to call attention to the fact that there was a direct connection between hissing and the relation between the area of the crater and the cross-section of the tip of the positive carbon. My own observations in 1893 led to a conclusion somewhat similar to Luggin's, but yet differing in an important particular. It seemed to me that with hissing arcs the crater always *more* than covered the end of the positive carbon—that it overflowed, as it were, along the side. How far this is true will be seen from an examination of figs. 4, 5, 6 and 7, which show the shaping of the carbons under various conditions with silent and hissing arcs. These figures have all been made from tracings of the images of actual normal arcs, burning between carbons of various sizes. For fig. 4 the diameters of the carbons were the same, but the currents and lengths of arc were different. Fig. 5 is the image of a short hissing arc. For fig. 6 the positive carbons were all of the same size, and the arcs of the same length, but the current had four different values, while for fig. 7 the current and the length of the arc were the same for both (*a*) and (*b*), but the diameter of one of the positive carbons was twice that of the other. The figures were carefully chosen with special reference to the shaping of the positive carbons. For with normal arcs the shape of the end of a positive carbon, even taken quite apart from that of the negative carbon and of the vaporous arc itself, is capable of revealing almost the whole of the conditions under which the arc was burning when it was formed. It is possible, for instance, with a normal arc, to tell, from a mere drawing of the outline of the positive carbon and of its crater, whether the arc with which it was formed had been opened or enclosed, short or long,

* *Wien Sitzungsberichte*, 1889, Vol. xcviii. p. 1,192.

silent or hissing, burning with a large or with a small current for the size of the carbon.

Take, for example, fig. 4, and note the difference in the shape of the positive carbon with a current of 3 5 amperes as in (*a*), and with one of 34 amperes, as in (*b*). In the first case the tip of the positive carbon is rounded, so that the crater lies in its smallest cross-section; in the second, the tip would be practically cylindrical for some distance, but that the crater has burnt away a part of the cylinder, making the tip look as if it had been sheared off obliquely. Comparing now the tips of the positive carbons when the arc is silent and

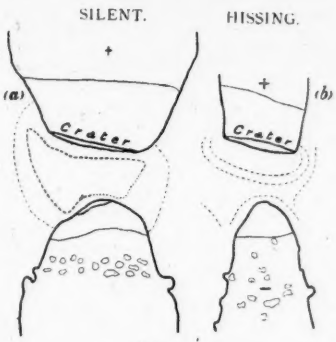


Fig 7.

Carbons —(*a*) Positive, 18 mm. cored; negative, 15 mm. solid. (*b*) Positive, 9 mm. cored; negative, 8 mm. solid.
Length of arc, 5 mm.; current, 25 amperes.

when it is hissing in all the four figures, 4, 5, 6, 7, we find the same difference. With all the silent arcs the tips are more or less rounded, and the crater lies in its smallest cross-section and consequently is less in area than any but the smallest cross-section. With all the hissing arcs, on the other hand, the tip of the positive carbon is practically cylindrical for a short distance at least, or would be but that it is sheared away by the crater; consequently the area of the crater is *greater* than the smallest cross-section of the tip, or indeed than the cross-section of the tip for some little distance along its length.

We have now arrived at the real, the *crucial*, distinction between a silent and a hissing arc. When the crater occupies the *end* of the positive carbon only, the arc is *silent;* when it not only covers the end, but also extends up the *side*, the arc *hisses*. Hence, the arc must be at the *hissing point* when the smallest increase in the area of the crater will make it begin to cover the *side* of the positive carbon, and this can only be when the tip of that carbon has very nearly the same cross-section for some little distance from its end—in other words, when its sides are nearly vertical.

I shall now proceed to show that the extension of the crater up the side of the positive carbon is not the *effect* but the *cause* of hissing; that, in fact, hissing is produced by the crater becoming too large to occupy the end only of the positive carbon, and by its, therefore, extending up its side.

This seems an absurdly simple and inadequate cause to produce such complicated phenomena as those belonging to the hissing arc, but it is the true one, nevertheless. Before I proceed to prove this, I will show how the laws for the largest silent currents with normal arcs, which have been already obtained from the electrical measurements on pages 3 and 5, may be deduced on the above hypothesis from figs. 6 and 7.

In fig. 6 we have a series of four normal arcs of the same length, burning between solid carbons of the same diameter, but in (*a*) the current is 6 amperes, in (*b*) 12, in (*c*) 20, and in (*d*) 30 amperes. The bluntness of the tip of the positive carbon may be measured by the obtuseness of the angle, A B C. In (*a*) the tip is very blunt, and the area of the crater is certainly less than any but the smallest cross section of that tip; therefore the arc is certainly silent. In (*b*) the tip is less blunt, but the arc is still evidently silent; in (*c*) the angle, A B C, is much more nearly a right angle, and it is plain that a very small increase in the area of the crater would cause it to burn up the side of the tip, therefore the arc is near the hissing point. In (*d*) the angle, A B C, is practically a right angle, the tip of the positive carbon is cylindrical, and the crater has evidently burnt partly up its side. Thus, keeping the length of the arc constant and gradually increasing the current must gradually bring us to a hissing point.

Next, I have shown elsewhere * that with a constant current the end of the positive carbon becomes rounder and blunter, and occupies a larger portion of the entire cross-section of the carbon rod the more the carbons are separated. Hence, the longer the arc, the greater must be the area of the crater, and consequently the greater must be the current, before the crater extends up the side of the positive carbon. Consequently, the longer the arc, the greater is the largest silent current.

Thirdly, it follows that when the current and the length of the arc have been increased to such an extent that the tip of the positive carbon occupies the whole cross-section of the carbon rod itself, no further increase in the size of the crater is possible without a part of it extending up the side of the positive carbon. Hence the largest silent current for a positive carbon of a particular diameter cannot exceed a particular value, however long the arc may be made. And, lastly, similar reasoning used in conjunction with fig. 7 tells us that the thicker the positive carbon the greater must be the largest silent current for a particular length of arc, which was one of the results deduced from the curves in figs. 2 and 3.

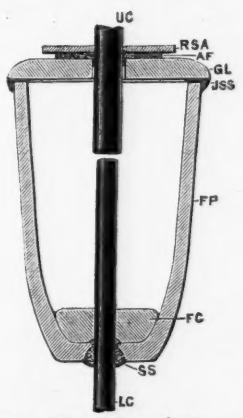
Consequently, the fact that hissing occurs when the crater covers more than the end surface of the positive carbon and extends up its side, combined with our knowledge of the way in which the positive carbon shapes itself in practice, is sufficient to enable us to deduce *all* the laws given elsewhere, which govern the largest current that will flow silently with the *normal* arc under given conditions.

It is also now obvious why, when the arc is *not* normal, it may be made to hiss with small currents, or be silent with quite large ones. For suppose, for instance, the end of the positive carbon were filed to a long fine point, then a very small current would make a crater large enough to extend up the side of the point, and produce a hissing arc. Whereas, on the contrary, if the end were filed flat, so as to have as large a cross section as possible, quite a considerable current could flow silently even with a short arc, for in that case it would require the current to be great for the crater to be large enough to fill up the whole of the end of the positive carbon.

We come now to the question, why should the arc hiss when the crater burns up the side of the positive carbon—what happens then that has not happened previously? In pondering over this question, the possibility occurred to me that, as long as the crater occupied only the end surface of the positive carbon, it might be protected from direct contact with the air by the carbon vapour surrounding it, but that, when the crater overlapped the side, the air could penetrate to it immediately, thus causing a part at least of its surface to *burn* instead of volatilising. Many circumstances at once seemed to combine to show that this was the true explanation. The dancing circles I had observed, and Mr. Trotter's stroboscopic images, how were they caused but by draughts getting into the arc? Then the humming noise, which I long ago described as sounding like the wind blowing through a crack, was not this probably caused by the air rushing through a slight breach in the crater already getting near to the critical size? This air, pouring in faster and faster as the breach widened, would cause the arc to rotate faster and faster, sometimes in one direction, sometimes in another, according as the draught was blown from one side or the other. Then finally the air would actually reach the crater, burn in contact with it, and the P.D. would fall and the arc would hiss.

In the open arc, whether silent or hissing, the outer envelope of the vaporous portion is always bright green. With the hissing arc the light issuing from the *crater* is also bright green or greenish blue. What so likely as that the two green lights should have a common origin, viz., the combination of carbon with air? For the outer green light is seen just at the junction of the carbons and carbon vapour with the air, and the inner one only appears when air can get direct to the crater.

Again, why does the arc always hiss when it is first struck? Is it not because a certain amount of air must always cling to both carbons when they are cold, so that when the crater is first made its surface must combine with this air?



U C, Upper carbon; R S A, Ring of sheet asbestos; A F, Asbestos fibre G L, Graphite lid; J S S, Joint of sodium silicate and Plaster of Paris; F P, Fireclay pot; F C, Fireclay cement; S S, Sodium silicate and Plaster of Paris cement; L C, Lower carbon.

Fig. 8.

The cloud that draws in round the crater when hissing begins would be a dulness caused by the air cooling the part of the crater with which it first came into contact, the bright spots being at the part where the crater and air were actually burning together. In fact, everything seemed to point to the direct contact of crater and air as being the cause, perhaps not of the hissing *sound*, but of the diminution in the P.D. between the two carbons, which is the important part of the hissing phenomenon.

One easy and obvious method of testing this theory immediately presented itself. If air were the cause of the hissing phenomena, exclude the air, and there would be no sudden diminution of the P.D. between the carbons, however great a current might be used. Accordingly I tried maintaining arcs of different lengths in an en-

* The *Electrician*, 1895, Vol. xxxiv., p. 614.

closed vessel, and increasing the current up to some 40 amperes. *No* sudden diminution of the P.D. could be observed with any of the currents or lengths of arc employed, although when the same carbons were used to produce *open* arcs, the sudden diminution of 10 volts in the P.D. between the carbons occurred with a current as low as 14 amperes for a 1 mm. arc.

Indeed, so far from there being any sudden diminution in the P.D. when the current through an *enclosed* arc is raised to higher and higher values, the P.D. appears to slightly increase for large currents.

It was, of course, impossible, in these experiments, to avail myself of an ordinary enclosed arc lamp, since a current of only some 5 or 8 amperes is all that is used with such a lamp, whereas to test my theory it was necessary to employ currents up to 40 amperes, although my carbons were of smaller diameter than those fitted in ordinary commercial enclosed arc lamps. Accordingly I constructed little electric furnaces, some made out of fire-clay crucibles with lids of graphite sealed on, as in fig. 8, some moulded out of fire-clay with mica windows inserted, so that the image of the arc could be projected on to a screen, and its length kept constant, some constructed of iron lined with asbestos. Some had tubes inserted in them through which the air could be admitted when required, &c.

It was found that when the vessel was entirely enclosed, the pressure in it was so great, on the arc being first started, that occasionally the lid was blown off. Consequently the space between the positive carbon and the asbestos ring was left open till the arc was well started, and then was tightly closed. This sudden increase of pressure probably took place when the carbons were first *brought into contact*, for Mr. Seaton,* while conducting some experiments for Messrs. De la Rue and Müller in 1879, observed that when the arc was completely enclosed the increase of pressure when the carbons were first brought into contact was far greater than could be accounted for by the rise of temperature of the gas in the vessel, and that the pressure fell, the moment the carbons were separated, almost to what it had been before contact was made. This fact was confirmed by some experiments made by Stenger† in 1885. This first great rise of pressure may, of course, be partly caused by the gases occluded in the carbons being expelled on the current being started, but a complete investigation of this phenomenon has not, as far as I am aware, yet been made.

(To be continued.)

INSPECTION OF ELECTRICAL CAR EQUIPMENT.

To emphasise the necessity of careful and thorough inspection of car equipment, Mr. A. B. Herrick in the *Street Railway Journal* mentions that he has found the repairs to the 22 feet cars on two roads he has examined to be the same as on an 80-ton locomotive of the Pennsylvania railroad, doing an equal mileage with a full train of freight cars.

Car equipment is subject to vibration, jars, and severe electrical and mechanical stresses, not to name dust, and defects of the electrical portion of car equipment can only be made apparent in many cases by means of instruments. He has found the resistance of the rheostat of the controller to be four-fold what it should be. The resistance usually increases with age and it may thus happen that the car will refuse to start in the first position of the controller. Starting on the second position causes excessive stresses and heating, and also gives a disagreeable acceleration, especially with motors of large torque. This condition is the primary cause of many breakdowns, and it is often found that the armatures, fields, and controller are being constantly repaired when the only fault is in the resistance.

The contact resistances in the controller, and the carbon brushes, give very unreliable and variable results when measured with low potential test current, and it is necessary to pass a considerable current when testing so as to bring down the contact resistances to normal, and it is most convenient to employ current from the railway circuit. But the current varies much and the bridge method is not suitable under 0·1 ohm, nor at the other extreme over 500,000 ohms. It is useless in measuring accurately low resistances. Nor is Thompson's method suitable except by separating the differential coils electrically, so that the resistance between the two resistances to be tested will not interfere with the accurate comparison of the resistances to be tested.

An inspection test is simply a measurement of the equipment on each notch of the controller. Every road fixes its maximum and minimum standard for each type of equipment, a considerable range being at first allowed. Maintenance means the keeping of different controller points within the allowed standard, any part which fails to pass being removed before it is crippled, and at once repaired.

Field resistance will usually lower with age owing to annealing effects, but if it lowers more than 1 per cent. it is due to turns being short or to carbonising or leaking of the wire insulation. The result is to make an armature revolve more quickly in a weaker field, and to become overloaded in its effort to run the car and to carry the other motor. The result will be a burned out armature.

A leaked field is a prevalent source of trouble. Asbestos has been tried under the cotton winding, but this may so enlarge the wire as to prevent sufficient of it being wound on. Another method is to slush the coils, when being wound, in a solution of chalk, magnesia and water. This hardens, and prevents short circuits. Other things are used for the same purpose. In any case the fields must be well dried after treatment so as to expel moisture or solvent. Drying ovens should be well ventilated, or much moisture must inevitably remain in the coils and high insulation cannot be had unless the oven be well ventilated.

The resistance of a motor will rise 0·38 of 1 per cent. for each degree Centigrade increase of temperature, and the temperature test is best made by measuring the resistance when hot. The drop in volts across one field when running is the best method of testing whether the motors are taking equal loads when connected to a series parallel controller. When in series they are taking the same current and the drop across one field should be halved when thrown into multiple, if equal current is going to each motor. A difference of 8 per cent. is the maximum inequality allowable. With the differential method each coil takes the drop-off of one field of each motor, and the hand stands at zero in case of equality. As the speed increases, if the hand moves from zero, the inequality is due to air-gap difference. If the difference at all speeds is steady it is due to the unequal resistance of the two motors in multiple.

Armatures suffer from grounds, short circuits, open coils, broken leads, broken down commutator insulation and especially short circuit through the commutator ring. Detection is easy by a bar to bar test of the commutator, and may be made by means of a brush holder yoke clamped on the spindle with insulated brushes on the bars. By revolving these brushes round the commutator there should be constant reading all round if correct, but if wrongly connected there will be a change in values when the brush rests on a wrongly connected section. Two bars short-circuited will give lower readings than normal when they lie between the testing brushes. An armature ground will be shown when one of the measuring terminals is connected to the shaft, the grounded coil giving the lowest reading on the commutator. For insulation test the connections are as for a ground. The test plugs are removed and the dial turned to insulation test and plugs inserted in the exposed receptacles when the insulation is at once read in megohms.

Controller faults are bad finger contacts, short circuits of fingers, grounds, burnt-out segments, and misconnections, carbonised finger partitions which may cause destructive arcing. The burning of a second resistance, causing an open connection on the first step will be indicated by the first contact being bright.

A bad flash at either loop contact, where the loop is cut around the field, shows an open or poor field connection. A successful inspector needs to be keenly alive to all such external evidences of internal troubles. Historically, the first step in control was the simple rheostat in series with one or two motors as required.

Next came the placing of motors in series with each other, and with the resistance, and next the placing in multiple with resistance cut-out. At this point comes the so-called K controller which places part of the resistance in series with the two motors in multiple. The G type places one motor directly across the line potential with full resistance in series with the other, which is cut out step by step until both motors are directly across the line. No. 14 type has a separate resistance step in series with each motor, and these are cut out alternately in both the series and multiple controller positions. With a two-motor equipment in a 20-foot car, the car wire circuit is 217 feet long, and a No. 6 wire has given a 12-volt drop in this circuit alone. A few shillings extra spent on wire would save more than hundreds spent on the line.

Generally the weak points shown by over a thousand experimental tests are (*a*) Two-way connectors are responsible for much trouble. Every break in the continuity of the conductor system is provocative of discontinuity of operation. (*b*) A motor is not any better than its field. (*c*) Careless brush inspection causes more burned-out armatures than poor motormen. (*d*) Maintenance is more economical than waiting for breakdowns. The trend of recent improvements is towards the abandonment of insulators which oxidise or carbonise and become, in time, conductors.

Finally, high potential alternating insulation tests, usually considered a satisfactory means of testing, usually develop the faults they detect and curtail the natural life of armatures and fields.

* *Philosophical Transactions*, 1879, p. 159.
† *Wiedemann's Annalen*, 1885, Vol. xxv., p.31.

THE DIVIDEND EARNING PROSPECTS OF STREET RAILWAY COMPANIES.

We have no desire to damp the ardour of those who are interested in the promotion of electric traction schemes in this country. It is undoubtedly true that compared with Switzerland, Germany or the United States, our country has made slow progress in the adoption of the new motive power for traction purposes. We cannot now stop to consider the reasons for our position in the rear. The one fact upon which all are agreed, is that we are behind, and everyone of our own countrymen is desirous that we should improve our position as quickly as possible with the aid of British engineers and British manufacturing firms. But, we hope that those companies who are acting as pioneers in this movement and are obtaining concessions from municipal and other bodies will not over-estimate the value of these concessions on transferring them to the subsidiary companies. Over-capitalisation has been the bane of far too many industrial developments in the past, and we hope that the electric traction boom may escape its blighting influence. In order to show that there is need for care and discretion in estimating the value of tramway

and street railway concessions, we give below some figures from the 1898 report of the Massachussetts Street Railroad Commissioners.

This State possessed in 1898 1,644 miles of street railroads, and, during the year, 330,900,000 passengers were carried—an increase of 22,200,000 upon the numbers for 1897. The total investment in the companies owning these street railroads was £14,324,000 as compared with £3,591,000 in 1888.

The capital invested in these companies had therefore quadrupled since the introduction of electricity as a motive power. The average cost per mile of main street track had been £9,005, distributed as follows:—Construction expenditure, £4,695; equipment, £1,865; lands, buildings, power stations, £2,444

Of the 103 companies operating street railroads in Massachussetts, only 49 paid dividends in 1898. 32 of these paid 6 per cent. or over, the highest dividend of 8 per cent. being paid by 11 companies. The remaining 17 only returned 5 per cent. or under, to their shareholders. The average rate of dividend paid by these 49 companies was therefore 6·17 per cent; the capital represented by them was £7,010,000. This rate of dividend is not striking, and is much below that which some promoters' statements in the country would lead one to expect. The point upon which we would lay especial emphasis, however, is, *that 54 companies paid no dividends at all.* The capital of these companies is stated to have been £1,100,800, but there is some discrepancy here between the total investment and the respective shares of the paying and non-paying companies. £14,324,000 – £7,010,000 leaves £7,314,000, or over half the capital invested, as non-dividend earning. Possibly the discrepancy is due to some considerable portion of the total capital being in the form of bonds.

We may return to this subject at a future date, but we hope these figures will receive the attention of all interested either as promoters or shareholders in electric traction schemes in this country.

TRAIN RESISTANCE.

Writing to the *Street Railway Journal*, Mr. J. B. Blood doubts somewhat the accuracy of Lundie's formula for resistance, owing to the method used in finding it. His chief object, which seems a fairly reasonable one, is that a train when coasting is not under the same conditions as when being hauled. Vehicles are running free; there is, of course, little or less pull on the draw bar outside the proper centre line, and vehicles are not pulled to one or other rail. They run freely and presumably take a line of different resistance—probably of least resistance. He considers that the best system of making tests is to use electric motors.

Comparing different formulæ he considers that of Searles to be a good one. This formula is:—

$$P = 4{\cdot}82\ W + {\cdot}005\ V^2\ W^2 + {\cdot}00047\ V^2\ E^2$$

where W = weight of train and engine.
E = weight of engine only.
V = speed in miles per hour.
P = resistance in pounds.

Assuming a locomotive to weigh 35 tons, this becomes

$$R = 4{\cdot}82 + {\cdot}005\ M^2 + {\cdot}6\ \frac{M^2}{T}$$

where M is the speed; R, the total resistance in pounds; and T the train weight in tons. It is a low-speed formula.

Nelkner, in Bavaria, found $R = 6{\cdot}25 + {\cdot}004\ M^2$; also a low-speed formula.

Dodd proposed $R = 7 + {\cdot}20\ M$ for train only.

Lundie proposed $R = 4 + {\cdot}20\ M + \frac{14\ M}{35 + T}$.

He obtained his basis of figures from cars using electric motors and the eight extra bearings per car will increase resistance, so that the formula should give results too high for free cars. Mr. Blood considers the error of neglecting the motor friction, &c., is 41 per cent. of the actual train resistance, so that Mr. Lundie's figure of 12 lbs. per ton for 20 miles velocity should really be 8·5 lbs. for free cars.

While it is probable that using the second power of the velocity is correct it does not perhaps matter so much at small velocities, while above 50 miles velocity it gave too high results. Hence the reaction in favour of only admitting speed at its first power as Lundie has done. Rankine did the same, but most of the earlier formula makers used the second power of M in the second term of their equations.

There are three main factors: Journal resistance, approximately constant at all speeds; track resistance, which varies with the speed; and wind resistance, which varies as a function of the speed to a power between first and second. A general form of the formula would thus be:

$$R = B + W\ M + A\ \frac{M^n}{T},$$

where B is the journal coefficient, W the track coefficient, A the air coefficient, and n the exponent which must be experimentally determined by results. B will vary from 3 to 6 according to excellence of bearings and pressures on them. With good rails and wheels W will be ·15, and would increase as conditions were less favourable. A depends on the cross-section of the train, and n, as above stated, is to be determined by trial. It must be above 1, and is probably less than 2.

In applying the most reliable data in his possession, he finds that a formula which would represent good practice would be:

$$R = 4 + {\cdot}15\ M + {\cdot}30\ \frac{M^{1{\cdot}8}}{T}.$$

It appears to be immaterial for trains over 200 tons at less than 40 miles per hour if n be taken at its first or second power, which seems to explain, possibly, the change in the speed formula as weights have grown heavier.

Letters are published also by other engineers who have taken the opportunity of discussing the Lundie formula. They are chiefly unimportant, but Mr. G. W. Knox considers that Lundie finds results much too small for tramway work, where rails are dirty. He made tests some years ago on rails nearly new and others badly worn. For the same weight of car 4½ tons at 12·9 and 10 miles speed the resistances on badly worn rail were 43·8 and 40 lbs. per ton, and on nearly new rail at 12 and 11·4 miles 26 and 30 lbs., while at 8·6 and 8·8 miles for worn and nearly new rails he found 37·2 and 24·2 lbs. Roughly, therefore, the old rails required 50 per cent. more traction, and the acceleration was, of course, less rapid. In the bad rail the wheels were sometimes running on their flanges. He emphasises the false economy of bad track, and when some of our electric lines have been at work a few years it will be interesting to observe the increase of traction for same number of cars as shown by the coal bill or the indicator. We think it would be found to pay to make better use of a groove plough and a track sweeper than appears to be the case on some tramways. A clean groove and a clean topped rail must be very efficient coal economisers.

THE STRENGTH OF BOILERS.

In his new capacity as engineer to the Manchester Steam Users' Association, Mr. Stromeyer is beginning to find out something about boilers, and the tendency of his remarks in a paper read before the Institute of Naval Architects was that we made boilers too strong. The strength of flat plates as per formula, and their actual strength as seen in the end plates of Lancashire boilers, where unsupported areas 10 inches from stay to stay are standard, was compared, and generally the author appeared to be of opinion that English boilers were too heavy and strong. American practice, with no better material, and with inferior workmanship, allows much higher pressures than English practice. The ratio is about 80 : 100. On the Mississippi River even heavier pressures are allowed. It is undoubtedly a fact that in English practice there is a very large margin of safety, and our present high pressure boilers are infinitely safer than the poorer constructions of 20 or 30 years ago. In the days of iron boilers a 7 feet diameter shell $\frac{7}{16}$ thick was allowed 56 lbs. pressure if single riveted and 75 lbs. if double riveted, and, moreover, the holes would be punched and the plates badly bent. Since that time holes have been drilled, plates have been more carefully bent, and there has been much attention given to the question of riveting, but steam pressures are not proportionately greater after due allowance has been made for steel in place of iron, and for the absence of the drift as used on carelessly-punched holes.

Very little increase has been allowed for improved workmanship and materials. In America boiler plates are stamped with their ultimate tenacity in pounds per square inch of cross-section, and pressures allowed accordingly. We cannot quite approve of this, as the tendency is towards high tension material to the possible neglect of ductility, and it is an axiom of English boiler making that ductility should come first. Indeed, the strength of a plate may in a sense be left to take care of itself so long as the ductility is properly secured. Somewhat higher tensile strength is allowed in furnaces where rigidity is of greater value than in shell plates and ductility less called for. But it must never be forgotten that ductility is after all vital in furnaces, even though it may not be called for until an overheating collapse takes place. It is then that ductility steps in and saves the plate from rupture by stretching under load. Mr. Stromeyer's paper is an endeavour to grapple with a somewhat vexed question. He is certainly right in stating that our extreme caution does handicap us in competition with foreign work of equal nominal strength, but actually less by probably 20 to 25 per cent.

TOO MUCH INDIVIDUALISM.

The *Engineer* very pointedly and accurately accuses Great George Street, Westminster, of having practically ruined British locomotive building. This is so. By Great George Street we understand that class of engineer which draws out rigid specifications for work which, in the first place, demands a full set of new drawings, then patterns and templates. All this means time and money, and rapid delivery is impossible. As a result there can be no stocking of standard parts, and when there is a push for locomotives the orders go to America, and engines are turned out there to standard designs like tin tacks, and, of course, cheaply and quickly. Though inferior in workmanship they are good machines, but they are not so good as our own locomotive builders would produce on similar lines and with the same freedom. The marvel to us is how the Great George Street clique can have the effrontery to put forth such specifications. It is not in locomotives alone, but in every branch of business that the same evil is found. The kind of specification we mean is familiar to

all. Full of the most absurd regulations and clauses it is impossible to make to it. Possibly one of the contributing causes is that engineers—of the sort—are so plentiful that they feel constrained to make their individuality felt, and this they do with a vengeance, but they secure no respect, neither any admiration for their constructive and mechanical ability. In many cases their specifications are mere colourable plagiarisms from out-of-date books, and betray an utter absence of knowledge of present day methods, and even materials. We frequently find most elaborate drawings of works to be carried out on lines which are almost antediluvian. An utter absence of scientific knowledge is only too obvious. Yet contractors who know better are not allowed to have a say in anything, and are frequently compelled to go out of their way to purchase out-of-date material at double the price they could afford to supply materials doubly as good.

The evil has been more pronounced, perhaps, in the case of locomotives for abroad than in other items, and the result is simply disastrous. There is not a single locomotive works in Great Britain to-day which can be called large. No growth has been possible under the chilling effect of Great George Street, which has controlled and checked the business. It would not matter so much if the same conditions were imposed on the foreigner. But when the pinch comes and orders must be placed for rapid delivery, the American works gets it without conditions. We believe that the same evil influence has attended upon and ruined our bridge building business, and we believe it will be found that the Atbara bridge has gone to America through similar reasons to the above. American bridge building has been standardised. Our own has been held in Great George Street trammels, and we have no hesitation in saying that any good engineer with an American text-book on the subject could get out designs for railway bridges better than the majority which emanate from Great George Street. Yet both in locomotives and bridges England ought to hold the field. The best English bridges and locomotives are not excelled anywhere. Why cannot they all be the best? The answer is, Great George Street specifies otherwise.

ELECTRIC LIGHTING IN THE CITY.

Board of Trade Inquiry.

(*Concluded from page 575.*)

On Tuesday morning Sir Courtenay Boyle, Permanent Secretary of the Board of Trade, resumed the inquiry at the Guildhall into the applications made by the Metropolitan Electric Supply Company, the Charing Cross and Strand Electric Supply Corporation, and the Smithfield Markets Electric Supply Company, for provisional orders within the City of London.

Mr. Crawford, the City solicitor, in answer to Sir C. Boyle, stated that a special meeting of the City Corporation had been held the previous day, when a series of resolutions were passed. One resolution was, that the Corporation would prefer at present to withhold evidence, so leaving them free to consider the question of undertaking the establishment of its own supply. A question had arisen regarding the contract entered into between the City of London Company and the Commissioners of Sewers, and Mr. Danckwerts had given the opinion that the contract between the Corporation and the City of London Company was null and void. Further, the Corporation did not desire to express any preference for one or other of the companies applying to institute a supply in competition with the present purveyors. The Corporation was further of opinion that the Board of Trade should not dispense with the consent of the Corporation unless in the case of an application from one who was prepared to accept the insertion in the provisional order of such terms and conditions as would secure the immediate and future interests of private consumers and the public; that should the Board of Trade decide to grant competition in the City it should be subject to the Corporation having the right to purchase the whole of the undertaking, whether within or without the City, on terms to be previously agreed upon by the Corporation and set out in the provisional order, and that provision should be made in the provisional order to guard against the possibility of competition between two competing undertakings to the disadvantage of the electric light consumers and of the City of London.

Mr. D. J. Ross, the City of London engineer, said he had had a great deal to do with the installation of electric light. There was no doubt that the placing of electric lighting mains in the City would cause serious inconvenience to the public. When the City of London Company laid their mains he knew that £30,000 was spent in replacing the pavements. He thought that competition would cheapen the light. The mains of the City of London Company were laid beneath the footways, and he did not think there would be any room for further mains. If the mains had to be laid below the carriage way the public inconvenience would be greater. All failures in the public electric lighting were penalised. In 1892, when the service was not complete, the fines were £119 on a total payment of £3,341; in 1893, £136 on £11,946; in 1894, £138 on £12,785; in 1895, £136 on £12,819; in 1896, £362 on £12,841; in 1897, £352 on £12,955; and in 1898, £156 on £12,927. He thought that showed that the company were in a better position to meet its obligations in 1898.

Mr. Pope (for the City of London Company): If a second company were to come in the inconvenience would be largely increased?—It would be largely increased from the fact that the carriage-way would have to be used.

Further examined by Mr. Pope, Witness said that the public lighting was entirely ruled by agreement. He believed that the mains which already existed were sufficient to meet any demands in the City.

Mr. Shiress Will: Do you think that competition in electric lighting in the City would be a public advantage?—I can scarcely answer that.

Is that because you have not inquired into the question or because of your public position?—Until all the circumstances connected with competition are stated it is very difficult to express an opinion.

Further cross-examined, Witness said he should say there were a great many more pipes and mains in the streets of the City than in the Strand or Westminster. In Cheapside it was difficult to find room for a tube.

Replying to Mr. Balfour Browne (for the Smithfield Company) Witness said he did not know about the Smithfield Company's undertaking. He did not know that the Smithfield Company had offered to supply electric light to the public buildings in the City. He had no knowledge of what penalties had been recovered from the City of London Company by private consumers.

In reply to Mr. Fitzgerald, Witness said he had always considered the charge by the City of London Company for public lighting to be very low. He could not tell any place where the charge was higher.

By Mr. Gray (for the Corporation): The number of complaints when the company laid its mains were not so many as they might have expected, and that, he supposed, was because they expected advantages from it.

Sir C. Boyle: Can't you give me any idea of what number of customers would take the light if the cost was lower as compared with the present 7,000 customers of the City of London Company?—I could not. The premises are occupied by persons of so many different occupations that it is impossible.

Mr. Pope, Q.C., addressing the Court for the City of London Electric Lighting Company, said that it seemed to him that the attitude of the City Corporation was one of the main factors in the case. He did not think it was for him to discuss whether the agreement between the Corporation and the company was a valid one or not, because that was a question for the Corporation and the company only. The simple question was this—is the attitude of the City of London that of consent to competition within the City area? If it was not, then he should contend that no such special circumstances existed in that case as to justify the Board of Trade in dispensing with that consent, and that therefore Clause 1 of the Act of 1888 practically would decide this question. The mere question of the advantage of competition would not justify the Board of Trade in putting aside the consent of the local authority, and he could find no other ground put forward by the applicants for orders except the common ground of the advantages of competition. The question was whether the Board of Trade should disturb what the Board of Trade had so far allowed without the consent of the contracting parties or of the local authority. It was obvious that there must be a great inconvenience in allowing another company to come into the City and break up the streets. The City of London Company had taken upon itself to lay mains over the whole area of the City whether the demand was remunerative or not, but if either of the applying companies were allowed to come in they would only break up the principal streets where there was likely to be a remunerative demand. He contended that it would not be fair to allow another company to come in, and it would have been wrong of the City of London Company to expend its capital in the lavish way it had had it not relied on the agreement which had been entered into. As far as he could judge from the resolutions passed by the City Corporation, he took it that they meant that if the agreement was a valid agreement they certainly would not be parties to breaking it. If, on the other hand, the agreement was void, it seemed that the Corporation would look on the whole field being open, and they wished to be allowed to consider their position in the matter. The position of the City Corporation at present was that they wished to be left alone to decide what they should do in the matter if the agreement was found to be void, and that certainly could not be taken to be a consent to other companies coming into the area. As far as the companies applying were concerned, he could only say, "a plague on all your houses." He would leave it to his friends to decide on their own merits and to find out which was the worst. He failed to find any special circumstances in the case which would justify the Board of Trade in dispensing with the consent of the local authority and introducing a new element into the City. It was obvious that the introduction of another company would complicate matters as regarded the question of purchase, and he considered that the Corporation were wise in being asked to be left alone. The strength of his case depended on the company's present position with the Corporation and the absence of the consent of the Corporation to the introduction of competition. But, further, he would point out this—that even in the criticisms which had been brought before the Court as to the service and administration of the company, no strong case had been made out of failure in the discharge of its duty to the City as to justify the Board of Trade saying that the City of London Company was unable or unwilling or too careless to carry out its duty to the public, and that that therefore was a ground for introducing someone else who would be in a position to correct their shortcomings. The City of London Company was now expending capital to improve its service, and he contended that it was deserving of the greatest consideration.

Sir Courtenay Boyle asked if the Corporation had decided to say anything.

Mr. Gray said that unless a statement was made which the Corporation decided to deal with they had no reply to make at all. He had nothing to reply to what Mr. Pope had said.

Mr. Fitzgerald (for the Metropolitan Company) said the position of the Corporation had been consistent throughout, but it was evident

that the Corporation looked to competition, because they said they wished to withhold evidence until they had considered the question of providing their own supply. They could only do that by the agreement being set aside. Further, the Corporation had resolved that they had no preference for either of the applying companies, and also that in the event of the Board of Trade granting an application it should be on condition that the question of purchase should be set forth. Counsel proceeded to set forward the advantages of competition and the failure of the City of London Company to meet the demands made upon it owing to a November fog. He considered that special circumstances had been shown why the Board of Trade should allow competition. If competition was to be allowed, he thought it would be between the Metropolitan Company and the Charing Cross Company, and the question was which company was in the best position to compete. His company had obtained a site at Willesden, which practically precluded them from being proceeded against as a nuisance, and they would shortly be in a position to supply the whole of the City with electric current, and leave a large margin for future increases. On the other hand, the Charing Cross Company had two stations—one just behind the Strand, and they were always liable to be proceeded against as a nuisance. The Charing Cross Company admitted that at present they were not in a position to supply the City. All the Charing Cross Company could say was that they had sites in view, and under those circumstances he said that the Metropolitan Company had the necessary capital, land, and credit to give a competing supply, and should be the company to be granted an order.

Mr. Shiress Will (for the Charing Cross and Strand Electric Supply Corporation), said that the fact that the City and Corporation had decided to stand by the agreement so long as it held good, and had thereby tied its own hands, was a sufficient reason for the Board of Trade dispensing with the consent of the Corporation. If the Charing Cross Company were to be allowed to compete, they would be willing to keep the generating station supplying the City separate, so that the Corporation could purchase the whole City undertaking. His company could show a remarkably good record in the past, both as regarded its activity and the reductions it had made in its charges. The price at which they were prepared to supply the City would be at once an advantage to the citizens. They had certain plant on order which, when erected, would enable them to increase their capacity to 360,000 lamps, whereas their present demands were 142,000 lamps. It was said that that margin would be required for the growing demands of the districts they had at present, but the company were quite prepared to erect a new station, but, of course, they could not be expected to go and buy a costly site until they knew whether it would be required. The evidence showed that many houses in the City would be lighted by electricity if the price was reasonable, and his company was prepared to supply at a reasonable price. With regard to a new site for generating electricity for the City, he would be prepared to give the position of the site to Sir C. Boyle before an order was made in his favour. The fact that the Metropolitan Company had got its large station at Willesden was against the Metropolitan Company, because the City Corporation could not purchase that site. Then the Metropolitan Company had a very large area at present, and the Board of Trade might well pause before adding to their obligations. Then one of the directors of the Metropolitan Company was the engineer of the City of London Electric Lighting Company, and he contended that the only way to secure effective competition was to allow a company to come in which was not in such friendly relation to the company in possession. As regarded the Smithfield Markets Company, it would appear that they simply made the application as an act of self-protection.

Mr. Balfour Browne, Q C, on behalf of the Smithfield Markets Electric Lighting Company, contended that monopoly should be swept away in the City of London. They had had 15,000 signatures of people in the City all wanting competition. Competition must come, and the only question was from whom the competition should come. The Smithfield Company was in the City and had been encouraged by the Corporation, and was in the best position to offer effective competition. His company's stock stood at par now, and they were prepared to find the necessary capital to compete in the City at an earlier date than any other company.

Sir C. Boyle said he would like to ask the counsel for the City Corporation whether independently of the power given under the Act of 1888 any local authority would have power to purchase any portion of an undertaking outside its district.

Mr. Gray: That is by no means clear. We might ourselves have to apply for a provisional order in order to do that.

Sir Courtenay Boyle said he meant not with a provisional order, but whether with a provisional order or without such order a local authority had power to purchase a portion of an undertaking outside its district. He understood that the City Corporation had different powers from other local authorities.

Mr. Gray, after consultation with the City solicitor, said it was understood that the City Corporation had the power to buy outside.

Sir C. Boyle: That will answer my purpose if I have that from the City solicitor.

Mr. Gray said he wished to state most explicity that the Corporation did not recognise the Smithfield Company in any shape or form. With regard to the applications, the Corporation had maintained the strictest neutrality.

This concluded the inquiry, and Sir Courtenay Boyle said the matter would receive his most careful consideration, and the Board would communicate with the Corporation before coming to any conclusion. He added that after listening to the addresses of counsel, he was like the lady in the story book who had heard the eloquent addresses of three suitors and did not know which to consent to.

Mr. Pope: Perhaps she consented to neither.

The inquiry then ended.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS. 1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

6,562. "Improvements in or relating to current regulators for electric batteries." M. E. Fuld. Dated March 27th. (*Complete.*)

6,592. "Electrical furnace with peripheral heating by means of electrical resistances." D. Lance, R. L. E de Bourgade, and L. Schmitz. Dated March 27th. (*Complete*) [Date applied for under Patents, &c, Act, 1883, Section 103, August 29th, 1898, being date of application in France]

6,593. "Improved combination brake coupling for electrically connecting railway vehicles fitted with vacuum brake for communication or signalling purposes." D. Cunningham. Dated March 27th.

6,604. "Improvements connected with motor road vehicles and in electric igniting apparatus for explosion engines." P. M. Justice. (The Pope Manufacturing Company, United States.) Dated March 27th. (*Complete.*)

6,624. "An improved switch or push for use in connection with electrical intercommunication on railway trains." A. Shiels. Dated March 28th.

6,631. "Improvements in and relating to electric switches and the like." L. B. Codd and P. N. Chatterley. Dated March 28th.

6,647. "Improvements in wall plugs for electric lighting and heating." A. P. Lundberg and G. C. Lundberg. Dated March 28th. (*Complete.*)

6,684. "Improvements in carbons for electric arc lamps." D. Bacon. Dated March 28th. (*Complete*)

6,685. "Improvements in voltaic cells." R. O. A. Heinrich. Dated March 28th. (*Complete.*)

6,687. "Improvements in porous diaphragms for electrolytic cells and methods of producing the same." H. H. Dow. Dated March 28th. (*Complete*)

6,690. "Improvement in method of and means for varying the speed of direct current motors." B. G. Lamme. Dated March 28th. (Date applied for under Patents, &c, Act, 1883, Sec. 103, September 3rd, 1898 being date of application in United States.)

6,691. "Improvement in systems of electrical distribution and regulation." B. G. Lamme. Dated March 28th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 28th, 1898, being date of application in United States.)

6,712. "Line circuits and apparatus for telephonic intercommunication." G. Aboilard et Cie. Dated March 28th. (Date applied for under Patents, &c, Act, 1883, Sec. 103, August 30th, 1898, being date of application in France.)

6,801. "An improved indicator for dynamometers." W. J. Murphy. Dated March 29th.

6,809. "A method of and apparatus for the transformation of two-phase electric currents specially applicable to electric welding." R. J. Wallis-Jones and W. B. Esson. Dated March 29th.

6,816. "Improvements in electric cigar lighters." W. F. Kessler. Dated March 29th. (*Complete.*)

6,819. "Improvements in electric switches." W. F. Jones. Dated March 29th.

6,820. "Improvements in or in connection with trolley or like current collectors for electric railways and tramways." B. Magrini. (B. Villa, Italy.) Dated March 29th.

6,833. "Improvements in step-by-step printing telegraph instruments." L. M. Casella. Dated March 29th.

6,847. "A safety device for contact rods of electric cars with overground line." L. Huber. Dated March 30th. (*Complete.*)

6,873. "Improvements in or relating to accumulators or secondary batteries." P. Prestwich. Dated March 30th.

6,883. "Improvements in apparatus for the production of electric discharges." M. Otto. Dated March 30th. (*Complete.*)

6,886. "A new or improved system of wiring electrical installations." F. Bathurst. Dated March 30th. (*Complete.*)

6,894. "Improvements in or relating to electrical measuring instruments." J. S. Townsend, H. A. Wilson, and J. A. McClelland. Dated March 30th.

6,960. "Improvements in electric arc lamps." H. Godsal. Dated April 1st.

6,963. "Improvements in electric cut-outs." H M. Darbah. Dated April 1st.

6,982. "Improvements in apparatus employed in wireless telegraphy." G. Marconi and the Wireless Telegraph and Signal Company, Limited. Dated April 1st.

6,992. "Improvements in switching contrivances for two electric incandescent lamps connected up together." W. Schloesser and H. Moebes. Dated April 1st.

7,001. "New or improved means for cutting down the current in incandescent electric lamps." A. E. Segnitz. Dated April 1st.

7,005. "Improvements connected with electric storage batteries." P. M. Justice. (The Pope Manufacturing Company, United States.) Dated April 1st. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. *(in stamps).*

1897.

6,251. "A combination watchstand accumulator or storage battery and electric lantern." S. F. Walling. Dated March 10th, 1897. *Watchstands.*—The watch is hung on a hook on the front of a box which contains an electric accumulator. On the base of the stand is arranged an electric accumulator. On the base of the stand is arranged an electric lantern which casts its light on the face of the watch. 2 claims.

6,353. "Electrical switch or contact maker or contact breaker." F. F. Teatman and W. Donovan. Dated March 11th, 1897. A cylinder or drum, having a number of flat faces and mounted on a spindle, suitably operated, carries contacts. These are connected or cross-connected, as by wires, in any desired order or arrangement, and engage with fixed contacts, of which there may be any desired number or arrangement according to the purpose of the switch as for controlling motors, &c. The apparatus may be used for holding a supply of fuses, the wires being connected across so that when one fuses a slight turn of the drum brings the next into position. A notched wheel engaging a pin holds the switch in position. 2 claims.

12,089. "Apparatus for controlling electric motor generators at a distance." Siemens Bros. & Co., Limited. (P. T. J. Estler.) Dated May 15th, 1897. Relates to means for controlling, as from the generating station, motor generators situated at a distance. The primary from the generating station is connected to the armature and also to a few coils on the field magnets of the motor, so that on switching on the current the motor can start. The generated current on the conductor is at first cut off from the distributing circuit by a switch, but flows through a solenoid, the core of which is attached to a lever pivoted, and loosely connected to a rod reciprocated by an eccentric on the armature shaft. This rod carries ratchet teeth, engaging when the rod is thrown over by the action of the solenoid with a wheel, thus moving the arm, and connecting the conductor with a contact, which is broken at the same time.

12,090. "A self-locking electrical signalling instrument." Siemens Bros. & Co., Limited, and G. Forrest. Dated May 15th, 1897. Relates to a self-locking indicator or visible signal-giving instrument, which is so arranged that, when operated by a current to display a signal, it is locked in that position until another signal is received. The signal indications are marked on the pivoted screen, which is normally locked to the right or to the left of its central position by a pin on the spring-controlled lever. The lower end of the lever is engaged by a pin on the tongue, which is pivoted on a permanent magnet. The cores of the electro-magnet are provided with yoke pieces, which are normally separated at their upper ends by a piece of brass or other non-magnetic metal. When a current is passed through the magnet, it attracts the keeper on the lever, and so releases the pin from the screen. The keeper, by connecting the yoke-pieces, so strengthens the magnet that it attracts the polarised tongue to the opposite side, and so moves the screen to display the proper indication. When the current is broken, the lever is returned by its spring to lock the screen in the position to which it has been moved.

12,128. "Improvements in apparatus for working railway points and signals by electric power." F. W. Welb and A. M. Thompson. Dated May 17th, 1897. Two tiers of levers for the points and signals respectively are connected to tappet locking arrangements, and also to the switches and check lock, where is a battery, a motor for operating and locking the points, a detector switch and a signal switch. Pairs of carbon blocks spring-carried on a detachable section of the rod rub over the carbon blocks, which are insulated from the frame, and are readily removable therefrom. The check lock consists of pawls, which are liberated from tappets on the continuation of the rod by electro-magnets. The motor shaft drives the shaft through worm gearing and two clutches, which act in opposite directions. These clutches are thrown in and out by a cam-wheel on the shaft, and are arranged to let the motor run free after one revolution of this shaft in either direction. On the sides of the wheel are two cam grooves shaped to act through bell cranks at proper intervals on the rods which move the points and lock them. The point lock may also be connected with a safety bar. Squared shafts and connections are employed, so that the armature and its shafts may be readily replaced. The locking bolt, which acts at both ends of its travel, and the safety bar, are worked by a three-armed crank, and rods which are connected to a detector bolt which engages two detector bars. A lever switch operated from the bolt, closes the circuits, which are connected to the check lock and the signal switch respectively. The signal is operated by a long pull magnet, which at the end of its stroke operates a switch to throw in a return circuit, including a resistance, so as to diminish the current to that required for holding the signal. The first movement of the point lever sends a current to the motor which operates the switch, which in turn, by the detector mechanism, sends a return current to the check lock and allows the movement of the point lever to be completed. The signal lever may then be operated.

12,134. "Improvements in the hanging of electroliers and other electric fittings." E. A. Clarremont and F. H. Royce. Dated May 17th, 1897. Supporting lamps. Electroliers and other electrical apparatus are hung so that they can be turned one or more, or less revolutions, but return automatically to their original positions when released. The supporting tube and a ceiling plate are provided with oppositely-threaded parts, connected by bearing balls in a threaded sleeve. Stops limit the travel of the balls. In another form, the supporting tube has a collar resting on a horizontal ring of bearing balls, within the ceiling attachment, and a helical spring connects this attachment with the tube.

18,730. "Improvements in and relating to motor vehicles for electric railways and tramways." S. H. Short. Dated August 12th, 1897. Relates to electric locomotives and motor vehicles, bearings, rheostats, and brakes of fig. 1 (sheet 2) shows the bearings for the motor shaft and driven axle. Liners C, made in halves with their junctions out of the line of thrust, are held in box castings U by dowels V. The box for the axle A is in two parts. Wells L in each box receive lubricant, and a spring S which presses waste against the axles through openings in the liners. Fig. 2 (sheet 3) shows the rheostats. Hubs A, with forked arms B, are strung on an axis in a casing, and a coil of strip iron with insulating material is wound in a mica trough in the arms. The ends of the strip are held by the clamp K, to which the inner end F of the adjacent coil and the wire P leading to the motor circuit are connected by binding screws. Fig. 1 (sheet 4) shows the brake. Bars D of copper pass through insulating sleeves in the rim of a brake wheel B, and are short-circuited on copper rings E. Brake shoes K bearing on the periphery of the wheel are hung on the ends of a magnet core which is energised from any suitable source, such as the trolley wire, or by causing the motors to act as generators. When the core is excited, there is an electric braking action in the induction bars D, as well as the frictional effect of the shoes K. This brake wheel may be mounted on the motor axles or on an intermediate or wheel axle. 24 claims.

18,801. "Improvements in electric switches." E. W. Lloyd and L. Newitt. Dated August 13th, 1897. Consists of a combination of a double knife switch and circular switch, and is adapted to connect any one of a number of generators to the circuit, being especially suitable for use on board ship. A carrier having a hollow spindle free to rotate, has pivoted to it two knife switches, and also the handle. A yoke embraces the handle and switch arms, and the spring gives a quick break. The fixed contacts may be connected to the generators and to the circuits. 3 claims.

18,865. "A safety device for use in connection with carriages propelled by electricity." Hon. R. T. D. Brougham and W. C. Bersey. Dated August 14th, 1897. Relates to electrically propelled carriages, and the object is to prevent unauthorised persons from starting the carriage when left by the driver. For this purpose a key box, with two open contacts inside, is interposed between one pole of the battery and the switch controlling the motor. A key of special design, which may be varied so that each key will fit only its own box is provided, to be inserted through the keyhole for connecting the two contacts inside. When the driver leaves the carriage he takes his key with him. 2 claims.

18,957. "Method designed to facilitate the coupling of wires for conveying an electrical current on railway trains." G. R. Powell. Dated August 17th, 1897. Couplings for railway vehicles are so arranged in connection with ordinary couplings that contact is made when the vehicles are coupled. A coupling arranged on the pipe coupling of a vacuum brake is as follows:—The wires are led at a suitable point into the tubes and connected to contacts embedded in insulating material in the interlocking parts. The contact is free to move and rests on a rubber spring. A hood or cover is preferably fitted over the coupling to protect the contacts when the parts are detached. In chain couplings the conductor is interwoven with the links, and then led along a groove in the hook to a suitable contact. A means is described for obtaining an air-tight joint when the wires are passed within the vacuum pipe. A tube having a suitably shaped head is passed through the hole, a washer being interposed. A core of rubber is fitted in the tube, and the wires passed through holes in it. A gland screw is next fitted and compresses the core. The joint is made tight by a shaped washer and nut. In a modified arrangement a tube screws into a hole in the pipe. 4 claims.

19,307. "Improvements in or connected with electric arc lamps." F. S. Worsley. Dated August 20th, 1897. Relates to arc lamps with differentially-acting coils for use in series, are provided with short-circuiting devices on the cores of the series coils, operating when the arcs fail. An iron block is placed so that under such circumstances the core is drawn into contact with it by the action of the shunt coil, in opposition to a spring. In the form described, a spring contact, carried by the core, then short-circuits the carbons by contact with a connecting piece between the series coil and carbons; the current is thus maintained through the series coil, and the core and block held together magnetically. In a modification, the block is insulated, and itself makes the short-circuiting contact with the core. 3 claims.

19,696. "Improvements in electrical ploughs." E. Edwards. (The firm of T. Gansel, Germany.) Dated August 26th, 1897. Relates to electric ploughs or digging machines in which the shears or digging tools are provided with helical blades and are rotated by gearing. The frame is supported on a front steering wheel operated by means of the gearing from the hand wheel and on two driving wheels driven by the band from the shaft. The shaft can be driven in either direction by a train of gearing from the motor, which is of ordinary construction. Current is supplied to the motor through main conductors connected to the springs carried by a swivelling bracket and in contact with insulated rings connected to the motor. The tools, of which any suitable number may be employed, are mounted so as to alternate with each other in frames suspended from the shafts connected together by links and connected by a link to a nut travelling on a stationary screw operated by gearing from the hand wheel either to lift the tools out of work or to adjust the depth of work. The tools are individually driven by bevel gearing from shafts driven by belts from the shaft. The implement is covered by a roof on which the supports for the rings are mounted. 5 claims.